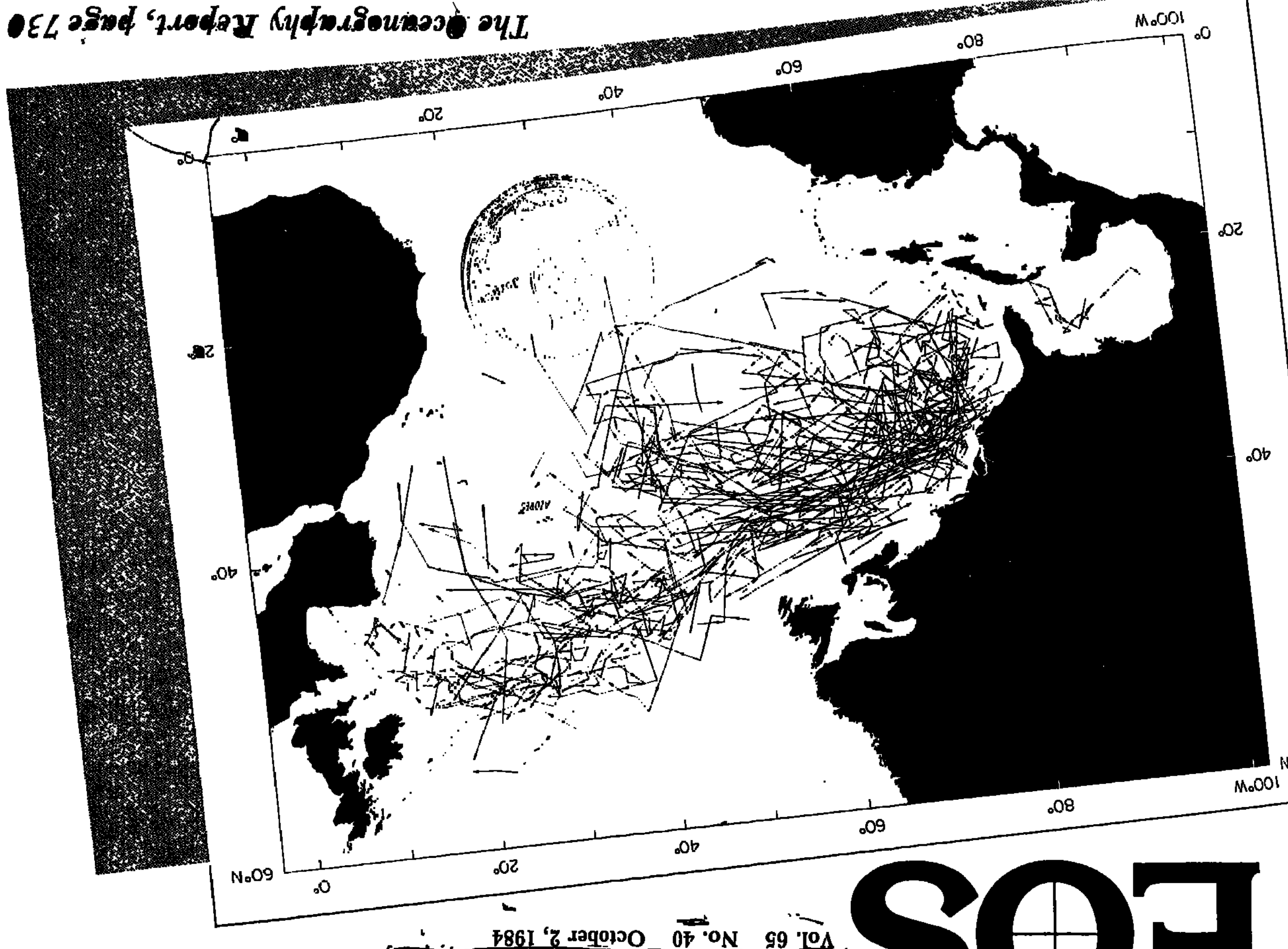
The Oceanography Report, page 730



EOS
Transactions, American Geophysical Union
Vol. 65 No. 40 October 2, 1984

Eos, Transactions, American Geophysical Union Vol. 65, No. 40, Pages 729–744 October 2, 1984

Seismology

6970 Structure of the Crust and Upper Mantle (Seismology)
DEEP BASEMENT SEISMIC REFLECTION PROFILING OF THE PURCELL ANTICLINORIUM USING A LAND AIR GUN SOURCE
F.A. Cook (Department of Geology and Geophysics, University of Calgary, Calgary, Alberta T2N 1N4)

Seismic reflection profiling in the Purcell anticlinorium of southern British Columbia, Canada using a land air gun source has revealed reflections from depths of at least 15–20 kilometers. Interpretations of these data, in conjunction with related geological and geophysical information, confirm the allochthonous structure of the Purcell anticlinorium and suggest that autochthonous North American basement at 15–20 kilometers depth beneath the anticlinorium has a westward dip of 15°–20°. The thickness of the crust above the North American basement surface may be accomodated by structural repetition of Purcell strata, by thrust slices of North American basement rocks, or by both. The geometry observed on the reflection data implies the Purcell anticlinorium is cored by a crustal-scale thrust anticline (hanging wall anticline). Further, the data demonstrate that land air guns are effective sources for crustal reflection work. (Seismic methods, Tectonophysics).

J. Geophys. Res., B, Paper 4B1179.

6970 Structure of the Upper Mantle
THE DEPTHS OF THE DEEPEST DEEP EARTHQUAKES
Philip B. Stark and Cliff Frohlich (Institute for Geophysics, The University of Texas at Austin, Austin, Texas, 78712)

The maximum depth of seismic activity is a fundamental observation providing a constraint on models of mantle dynamics. Although recent investigations of mantle seismicity and dynamics generally state that seismicity extends to "about 700 km," large earthquakes with focal depths of 720 km have been reported, as have small events with depths exceeding 800 km. We have examined focal depths of events in several catalogs and concluded that the deepest events with reliable focal depths occur at about 670–680 km, and events with focal depths exceeding 600 km occur in several widely separated geographic regions. Events with reported focal depths exceeding 680 km generally possess inconsistent observations, or very few observations. The termination of seismic activity beneath about 650 km is quite abrupt. However, we cannot determine whether activity stops completely at 670–680 km, or whether the maximum size of events decreases gradually beneath 650 km, with magnitudes of 6.5–7.0 occasionally occurring at 650 km, magnitudes of 5.5–6.0 at 680 km, 4.0–4.5 at 695 km, etc. Several models can explain the absence of seismic activity in the lower mantle. Two models are consistent with both the abrupt termination of activity and its occurrence at about 650–680 km in widely separated geographic regions. These are either a barrier which resists penetration of the subducting lithosphere, or a phase transition which modifies the properties of the subducted material as it goes into the lower mantle. (Deep earthquakes, mantle convection).

J. Geophys. Res., B, Paper 4B5049.

Social Sciences

7310 Economics
SOLAR ENERGY AND HYDROELECTRIC POWER GENERATION IN THE DEAD SEA: A DYNAMIC ANALYSIS
B. Hochman, J. LaFrance (Department of Agricultural Economics and Economics, Montana State University, Bozeman, Montana, 59717) and D. Zilberman

A dynamic optimal control model is developed for generating hydroelectric power in the Dead Sea. Properties of the optimal utilization path and steady state equilibria are analyzed, and the applicability of the model for other types of water development projects is discussed. Estimates of the basic equations for the Dead Sea project and a numerical application are presented. (Optimal control, solar energy, hydroelectric power, natural resource economics).

Water Resour. Res., Paper 4W1100.

7310 Economics
EX-POST EVALUATION OF FLOOD CONTROL INVESTMENTS: A CASE STUDY IN NORTH DAKOTA
K. Palanisami (Department of Agricultural Economics, Tamil Nadu Agricultural University, Coimbatore, 641003, India) and K. William Easter

Ex-post estimates of a flood control project in North Dakota are compared with the Corps of Engineers ex-ante estimates. Ninety-two percent of the ex-ante benefits were supposed to come from water supply and the rest from flood control. Based on 32 years of data, the ex-post estimates showed zero water supply benefits and flood control benefits 37 times higher than ex-ante estimates. These added flood control benefits resulted from an increased frequency of flooding beginning with the first two years of the project's operation. Finally the ex-post analysis found that commercial fishing and recreation benefits accounted for 28 percent of the ex-post benefits. (Flood control, ex-post project analysis)

Water Resour. Res., Paper 4W1166.

Solar Physics, Astrophysics, and Astronomy

7710 Corona
CHARACTERISTICS OF CORONAL MASS EJECTIONS ASSOCIATED WITH SOLAR FRONT-SIDE AND BACK-SIDE METRIC TYPE II BURSTS
S.W. Kahler (AFGL/PHP, Hanscom AFB, MA, 01731), E.W. Cliver, H.R. Sheeley, Jr., R.A. Howard, M.J. Koomen, and D.J. Michels

We compare fast ($v > 500$ km s^{-1}) coronal mass ejections (CMEs) with reported metric type II bursts to study the properties of CMEs associated with coronal shocks. We confirm an earlier report of fast front-side CMEs with no associated metric type II bursts and calculate that 33 ± 15% of all fast front-side CMEs are not associated with such bursts. Faster CMEs are more likely to be associated with type II bursts, as expected from the hypothesis of piston-driven shocks. However, CME brightness and associated peak 3 cm burst intensity are also important factors, as might be inferred from the Wagner and MacQueen (1983) view of type II shocks decoupled from associated CMEs. We use the equal visibility of solar front-side and back-side CMEs to deduce the observability of back-side type II bursts. We calculate that 23 ± 7% of all back-side type II bursts associated with fast CMEs can be observed at Earth and that 13 ± 4% of all type II bursts originate in back-side flares. CME speed again is the most important factor in the observability of back-side type II bursts. (Corona, flares).

J. Geophys. Res., A, Paper 4A8130.

Tectonophysics

8150 Plate tectonics
PLATE TECTONIC EVOLUTION OF THE ICELANDIC TRANSVERSE RIDGE AND ADJACENT REGIONS
M. H. P. Bott (Department of Geological Sciences, University of Durham, South Road, Durham DH1 3LE, U.K.)

The northeastern North Atlantic evolved in the following three stages: (1) 54–44 Ma ago, initial separation, (2) 44–26 Ma ago, separation of Jan Mayen microcontinent from Greenland with complementary fan-shaped spreading on both sides, and (3) 26 Ma ago to present, spreading about a single axis passing west of the microcontinent. Poles of rotation for each stage have been refined, and the plate tectonic evolution of the Icelandic transverse ridge in relation to adjacent regions has been reconstructed. During the early stage, the Iceland-Faeroe Ridge and the complementary east Greenland shelf were formed. The Faeroe transform fault separated the region from the Norwegian Sea and the spreading axis jumped westwards prior to anomaly 22. During the intermediate stage, the line of the Faeroe transform fault enabled the Jan Mayen microcontinent to slide out, with the development of a ridge-ridge-transform triple junction which migrated westwards, and the formation of a wedge-shaped region of crustal accretion joining the triple junction to the Aegir Ridge. The Greenland-Iceland Ridge eastwards of the shelf break and most of the Vestfirdir region of Iceland were formed during this stage. At the start of the last stage, the Reykjanes and Kolbeinsey spreading axes became joined by a new split which formed an eastward bulging embayment across the Icelandic transverse ridge approximately coincident with the eastern edge of the insular shelf of Iceland. The asymmetrical shape of Iceland itself, and of the whole transverse ridge, is explained by this reconstruction.

J. Geophys. Res., B, Paper 4B1168.

8150 Plate Tectonics
SOURCE MECHANISMS OF EARTHQUAKES NEAR MID-OCEAN RIDGES FROM BODY WAVEFORM INVERSION: IMPLICATIONS FOR THE EARLY EVOLUTION OF OCEANIC LITHOSPHERE
Eric A. Bergman and Sean C. Solomon (Dept. of Earth, Atmospheric, and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, MA 02139)

To investigate the early tectonic evolution of oceanic lithosphere, we present a synthesis of the characteristics of near-ridge earthquakes, i.e., earthquakes which occur off the axis of major mid-ocean spreading centers but in lithosphere less than 35 m.y. old. Near-ridge seismicity for the past two decades has been rather evenly distributed along the major ridge systems, with the exception of the central Indian Ocean and the eastern part of the Cocos plate, which have experienced a high rate of earthquake activity during that time. For 32 near-ridge earthquakes, we determined the double couple orientation, seismic moment, centroid depth, and source time function, using a formal inversion technique based on matching synthetic and observed P and SH waveforms. All types of faulting styles are observed. Seismogenic deformation in young oceanic lithosphere is concentrated in the first 15 m.y., and occurs almost entirely in the uppermost mantle, from just below the Moho to depths at which the temperature estimated from standard thermal models exceeds 800°C. Thrust faulting is not observed at depths greater than 10 km below the seafloor. The deepest near-ridge earthquakes are characterized by normal-faulting focal mechanisms, with the T-axis oblique or perpendicular to the local spreading direction; most of these earthquakes occur in the central Indian Ocean. The transition from mechanisms characteristic of ridge axes to those characteristic of the near-ridge environment occurs within the first few m.y. For lithosphere less than 35 m.y. old, horizontal compressive stress associated with the cooling and subsidence of the lithosphere ("ridge push") does not appear to be the dominant source of stress released in earthquakes; this result may be used to place a lower bound of several hundred bars on the typical stress difference in young oceanic lithosphere. This bound, together with the strain rate observed depth of faulting, implies that the strain rate associated with seismic deformation is locally at least 10^{-15} sec^{-1}. We propose that thermoelastic stresses associated with plate cooling play an important role in near-ridge earthquakes. This source of stress can account for the mechanisms and depths of many near-ridge earthquakes and for the concentration of activity in very young lithosphere. The comparative aseismicity of the oceanic crust may reflect the concentration of thermoelastic stress below the Moho due to different material properties for the crust and upper mantle or the early release of thermoelastic stresses through hydrothermal circulation and cracking throughout the crust at or near the ridge axis. The higher level of near-ridge seismicity in the Indian Ocean may be the result of modification or enhancement of the more typical near-ridge stress state by such local processes as the active continental collision between India and Asia or active secondary convection beneath the young lithosphere of the Indian plate.

J. Geophys. Res., B, Paper 4B0932.

News

Long-Range Space Objectives

At the request of the National Aeronautics and Space Administration (NASA) the National Research Council's Space Science Board has undertaken a special study of the long-term (post-1995) objectives of U.S. research in the space sciences. The study will continue over approximately 2 years and will involve two to three summer sessions as well as disciplinary group meetings during the intervals between the summer sessions. This special study is intended to build upon and considerably extend the strategy reports in the various space science disciplines that the board has been involved in formulating over the past few years.

In the first meeting of the entire study, held at Woods Hole, Mass., August 20–29, each of the disciplinary panels formulated a draft report on the present status of their sciences and the expected space science missions to the year 1995. These expected missions are based upon the science strategies as contained in the reports of the several committees of the Space Science Board. The individual task groups also developed, in a very preliminary fashion, scientific objectives and space science missions that might well be considered for implementation in the post-1995 era.

The study is organized around a steering group and is being conducted by this steering group plus six disciplinary panels, consisting of approximately 12 individuals each. Present membership of the steering group includes T. M. Donahue (Chairman), University of Michigan; D. Anderson, California Institute of Technology; R. Berliner, Yale; B. Burke, Massachusetts Institute of Technology; A. G. W. Cameron, Harvard; H. Friedman, NASA; D. Hunten, University of Arizona; F. Johnson, University of Texas, Dallas; S. M. Krimigis, Applied Physics Laboratory/Johns Hopkins University; E. Levy, University of Arizona; F. B. McDonald, NASA; L. Margulis, Boston University; J. Naugle, Fairchild Industries; F. Scarf, TRW; E. Stone, California Institute of Technology; S. Swisher, Michigan State University; J. A. Van Allen, University of Iowa; and R. Weiss, Massachusetts Institute of Technology. The chairs of the disciplinary panels are R. Weiss (Fundamental Physics and Chemistry), D. Hunten (Planetary/Lunar Exploration), B. Burke (Astronomy/Astrophysics), D. Anderson (Earth Sciences), F. Scarf (Solar/Space Plasmas), and L. Margulis and S. Swisher (Life Sciences).

Objectives of the task groups during the next year will be the continued definition and refinements of the long-term space science objectives and possible mission models on the basis of the expected positions of the various disciplines in 1995 as discussed in the past board strategies. In the next year there will also be concerted efforts to discuss widely within the individual constituent scientific communities the activities of the task groups and the planning processes that are ongoing. There is every intent to involve as wide a spectrum of the scientific community as possible in order to ensure that the very best ideas are considered for the post-1995 space science objectives of the nation.

This news item was contributed by L. J. Lanzerotti, Bell Laboratories, Murray Hill, N.J.

APEX: The Arctic Polynya Experiment

A field experiment has been initiated to address the mesoscale oceanographic, sea ice, and meteorological processes associated with a polynya, or high-latitude area of semipermanent open water and vigorous new ice growth. This experiment, called the Arctic Polynya Experiment (APEX), is taking place in and around the St. Lawrence Island Polynya on the northern Bering Sea shelf. This polynya was selected for study because it typifies many such features found throughout the Arctic and Antarctic, is relatively accessible, and lies in a region that is of considerable interest due to projected resource development.

A polynya is an open water area which persists despite environmental conditions which would seem to dictate formation of an ice cover. Such areas may be due to a variety of causes. The majority appear to occur, however, when a physical barrier, such as a coastline or a channel constriction, allows prevailing winds or currents to sweep newly formed ice away while at the same time preventing existing ice from moving into the area. The St. Lawrence Island Polynya occurs along the southern, or lee, coastline of St. Lawrence Island as the prevailing northerly winds sweep ice away toward the south. Polynyas are of oceanographic interest because they are sites for vigorous, continuous ice formation and are therefore sources both of new ice and of dense, brine-enriched water. They are of interest meteorologically because the associated strong sea-air heat fluxes modify the atmospheric boundary layer.

Oceanographic goals of the APEX program include estimation of the mesoscale heat, salt, and momentum fluxes associated with a polynya and definition of the dynamics which affect these fluxes. These goals will be addressed through time series current, temperature, and salinity observations obtained from oceanographic moorings. The data analyses will focus upon polynya-associated dynamics within the context of a coastal dynamics problem and will use descriptive analyses and simple analytic models. Goals of the APEX sea ice studies include estimation of ice formation rates and of the effects of the polynya on regional ice properties and dynamics. Field observations of ice motion will be obtained by using satellite-tracked drift buoys, and ice distribution will be observed with satellites. The analyses will integrate the observed ice distribution and motion with oceanographic and meteorological conditions through a numerical model. Meteorological program goals include estimation of mesoscale and boundary layer effects associated with the polynya. Meteorological conditions will be monitored by using remote recording and satellite transponding weather stations. The data will be analyzed in conjunction with computed regional winds to address the above goals.

The oceanographic moorings are presently in place, having been deployed in early October 1984 from the University of Alaska vessel *Alpha Helix*. It is planned that these moorings will be recovered using the same vessel, in May 1985. Meteorological stations and ice drift buoys will be deployed in February 1985 from a NOAA helicopter operating out of Nome, Alaska. The experiment is funded jointly by the National Science Foundation, the Office of Naval Research, and NOAA.

This news item was contributed by Robin D. Muench, Science Applications International Corp., Bellevue, WA 98005, and Carol H. Pease, Pacific Marine Environmental Laboratory, NOAA, Seattle, WA 98115.

Exclusive Economic Zone

Following President Reagan's declaration of an Exclusive Economic Zone (EEZ) in March 1983, the National Advisory Committee on Oceans and Atmosphere (NACOA) undertook a study to begin sorting out what implications the proclamation would have on existing and future oceans legislation and policy.

As a result of this proclamation and the Reagan administration's earlier decision not to sign the Law of the Sea (LOS) Treaty, much discussion has centered around whether or not the United States should attempt to formulate a comprehensive package containing all oceans-related legislation. According to the NACOA report "The Exclusive Economic Zone of the United States: Some Immediate Policy Issues," most experts argue against such a move. NACOA agreed, recommending that a comprehensive oceans package is not needed nor even desirable at this time. Instead, NACOA argues, emphasis should be placed on assuring that existing U.S. ocean policy is "consistent" with the nondeep seabed provisions of the LOS treaty. NACOA is a Presidential advisory committee that conducts ongoing reviews of national oceanic and atmospheric policy and reports directly to Congress and the President.

Another major NACOA recommendation called for a clearly defined system for dispute settlement, particularly regarding freedom of navigation through other nations' exclusive economic zones. In order to assure navigational freedoms, NACOA recommended that the United States should not implement any policy that goes beyond those provisions of the LOS treaty. Although disputes cannot be totally avoided, NACOA admits, a system of dispute settlements set up and agreed upon beforehand can help the United States reach timely agreements with other coastal nations. This may be particularly important, says NACOA, because existing treaties with coastal nations leave many gaps where disputes could develop.

A final major NACOA recommendation, now being acted upon, is to conduct a detailed "nuts and bolts" study to determine what implications the EEZ proclamation will have on existing U.S. legislation. The Outer Continental Shelf Lands Act of 1953 is a prime example. The Committee on Atmosphere and Oceans (CAO), a separate organization, is in the process of completing this report, which is due sometime in November.

In related news, NACOA has received funding of $630,000 through the end of fiscal year 1985, which began October 1. For the past several years the Reagan administration has attempted to eliminate NACOA by cutting its funding, but Congress, as was the case this year, has always intervened.—*DWR*

NRC Associateships Available

The National Research Council (NRC) has announced that some 2500 new full-time associateships will be awarded in 1985 for research in the sciences and engineering. Most of the positions are open to both U.S. and non-U.S. nationals and to both recent Ph.D. holders and senior investigators. Applications must be postmarked no later than January 15, 1985. The announcement of initial awards is expected in March and April 1985.

The associateships will be awarded on a competitive basis for research in chemistry, engineering, and mathematics and in the earth, environmental, physical, space, and life sciences. More than 20 federal agencies or research institutions located throughout the United States will participate.

Most of the awards will be made for 1 or 2 years. Applicants who have held doctorates for at least 5 years may request shorter tenures. Stipends beginning at $25,350 per year for recent Ph.D. holders will be awarded. A stipend supplement of up to $5,000 may be available to regular awardees who hold recognized Ph.D.'s in disciplines which fall significantly below the current demand of U.S. graduate schools. Last year these disciplines included engineering, computer science, and space-related biomedical science.

Further information, including applications, specific research opportunities, and federal laboratories participating, is available from Associateships Programs, Office of Scientific and Engineering Personnel, JH 608-D3, National Research Council, 2101 Constitution Avenue, N.W., Washington, DC 20418 (telephone: 202-334-2760).

Upcoming Hearings in Congress

The following hearing has been tentatively scheduled by the House of Representatives. The date and time should be verified with the committee or subcommittee holding the hearing; all offices on Capitol Hill may be reached by telephoning 202-224-3121. For guidelines on contacting a member of Congress, see *AGU's Guide to Legislative Information and Contacts* (*Eos*, August 28, 1984, p. 669).

October 10. Field hearing on U.S. ocean policy by the Subcommittee on Fisheries and Wildlife Conservation and the Environment of the House Merchant Marine and Fisheries Committee. Versailles Room, New Orleans Hilton Hotel, 2 Poydras St., New Orleans, La., 9 A.M.—*BTR*

NASA Guest Investigators

The National Aeronautics and Space Administration (NASA) is now seeking guest investigators to participate in the International Sun-Earth Explorer (ISEE) and International Cometary Explorer (ICE) programs. The ISEE/ICE project is a joint NASA/European Space Agency (ESA) venture. A budget of approximately $500,000 to support the ISEE/ICE Guest Investigator Program is expected for fiscal year 1985, and a similar amount is expected for FY 1986.

Although NASA welcomes proposals at any time, proposals must be received by mid-October in order to be considered in the initial selection. Those arriving after mid-November may be held for another selection period.

NASA's objective is to extend and augment established ISEE/ICE programs. Participation and use of data may take several forms. Researchers may use data already collected or plan special operations for future data acquisition and interpretation using program instruments that are already operating. In addition, theoretical interpretive studies in support of specific experimental results from ISEE/ICE may be conducted, as well as comparative studies combining data from another source with ISEE/ICE data.

Questions regarding this guest investigator program should be addressed to John T. Lynch, Code EE, NASA Headquarters, Washington, D.C. 20546 (telephone: 202-453-1676). Queries specifically regarding comet science only should be sent to William Brunk, Code EL, NASA Headquarters, Washington, D.C. 20546 (telephone: 202-453-1596).

Space Station Proposals

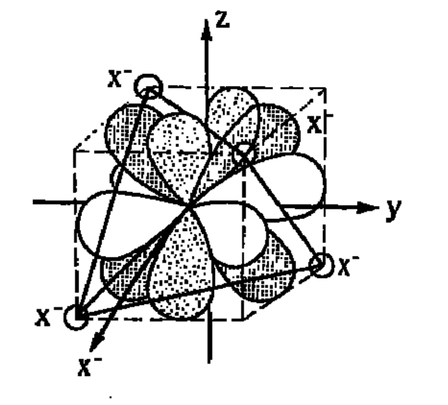
NASA has issued a request for proposals (RFP) for definition and preliminary design of a permanently manned space station. The station is to be operational in low earth orbit early in the 1990's. According to NASA, the station will "support scientific and commercial endeavors in space, stimulate new technologies, and enhance space-based operational capabilities." Proposals are due November 15, 1984.

Intended to be operational for several decades, the space station will include a number of pressurized modules and a power supply of 75 kilowatts, will support a crew of six to eight people, and will have two or more free-flying unmanned platforms.

The RFP includes four "work packages" covering preliminary designs of space station elements. Contracts to be let for each package are scheduled to begin April 1, 1985. The RFP also requires contractors to study the possibility of using automation and robotic technologies.

Final design and development of the station will begin in 1987. Overall system engineering and integration activities will be performed by NASA's Johnson Space Flight Center, Houston, Tex.

Mineral Physics News



The focal point for the mineral physics community.

Editor: Robert M. Hazen, Carnegie Institution of Washington, Geophysical Laboratory, 2801 Upton Street, N.W., Washington, DC 20008 (telephone: 202-966-0334).

What is Mineral Physics?

In the past the principal task of the mineralogist was simply to describe and classify physical, chemical, and structural properties of the remarkable variety of natural inorganic crystals. As this task was gradually accomplished for most species, however, mineralogists increasingly sought to identify physical and chemical principles that underly mineral formation and behavior and procedures that might lead to predictions of stability and properties of phases deep within the earth. Mineral physics, which has evolved during the past 2 decades, is thus the study of mineralogical problems through the application of the principles of condensed-matter physics and chemistry.

Mineral physics bridges gaps among a number of disciplines. Mineral physics is closely linked with traditional earth-science fields, including solid-earth geophysics, geochemistry, crystallography, petrology, and crystal chemistry. Close ties also exist with topics in ceramics, materials science, physical chemistry, high-temperature and high-pressure research, and solid-state physics. The range of materials studied parallels the diversity of minerals themselves: elements, metal alloys, sulfides, halides, layer compounds, and zeolites, in addition to rock-forming oxides and silicates, have been the focus of much study. Experiments on minerals and their analog compounds have intensified as new industrial applications have been found in the manufacture of lasers, high-performance ceramics, molecular sieves, catalysts, and a wide variety of electronic components.

The methodology of modern mineralogy, both experimental and theoretical, reflects the new objectives of mineral physics. A major focus for many mineral physicists is the precise determination of the physical constants of minerals. Shock-wave and static compression experiments, coupled with measurements of thermal expansion and other properties, are used to calculate equations-of-state for minerals. Ultrasonic and Brillouin-scattering experiments yield the elastic moduli of crystals. Other researchers measure thermal conductivity, electrical conductivity, and magnetic properties of minerals.

In addition to well known neutron, X ray and optical microscopic methods of the mineralogist, mineral physicists have adopted a wide range of spectroscopic procedures that reveal aspects of the structure and composition of minerals. Mössbauer, optical, and nuclear magnetic resonance spectroscopy probe the atomic environment and electronic state of ions in crystals. Raman and infrared spectroscopy reveal the molecular and lattice vibrations of mineral crystals. Microprobes that employ beams of electrons, X rays, and ions have led to ever more precise and spatially resolved compositional determinations.

Our knowledge of mineral structures has been enhanced by the application of transmission electron microscopy, which has revealed nonperiodic aspects of crystals including defects and stacking disorder. Quantitative thermochemical techniques, in particular a variety of calorimetric procedures, provide critical data on the internal energies of minerals. These experimental studies are complemented by computational quantum chemistry, which has led to predictions from first principles in a few simple cases of mineral structure, stability, and physical properties.

Concurrent with the application of these and other new mineralogical techniques has been the remarkable development of high-pressure and high-temperature apparatus for the measurement of mineral structures and properties at geologically-relevant conditions. Progress in diamond-anvil pressure cell technology (Figure 1) and applications of laser heating, in particular, have become major efforts in the mineral physics community.

Underlying much of the mineral physics research is a growing awareness of the dependence of macroscopic properties—particularly those structural and transport properties that influence geophysical behavior—on atomic-level interactions. A major effort, therefore, is underway to document interrelationships among mineral structure, bonding, physical properties, and stability. Such an understanding of minerals will inevitably lead to a more complete understanding of the structure and dynamics of the earth's interior.

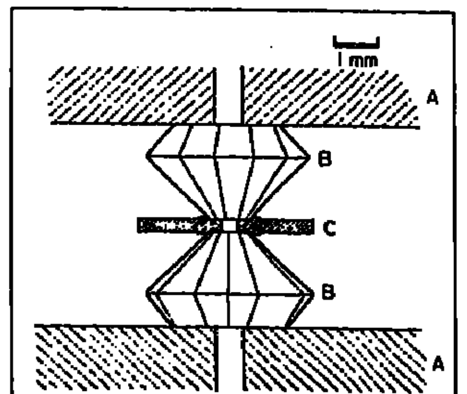


Fig. 1. The diamond anvil pressure cell is an important tool in mineral physics research. Static pressures up to 2.75 Mbars have been attained in studies of mineral properties.

Information Report

The Mineral Physics Committee

Mineral physics is a diverse field that includes the study of crystal structure, thermochemical properties, physical properties, equations of state, and phase equilibria of minerals and mineral analog compounds. All of these mineral parameters are interrelated, yet they have been traditionally studied and reported by members of different AGU sections. Equations of state and elastic constants are usually included in Tectonophysics, magnetic properties of minerals are often treated in Geomagnetism and Paleomagnetism, and crystal structure and phase equilibria routinely appear in sessions of Volcanology, Geochemistry, and Petrology. Other subjects of interest to the mineral physics community may be reported in Oceanography, Planetology, or Seismology. As a result, many closely related topics have been presented in conflicting sessions at AGU meetings. The extent of this problem was highlighted during the 1983 Spring AGU meeting, when at one point aspects of silicate mineralogy and petrology were discussed concurrently in seven different sessions sponsored by five different sections.

The AGU Executive Council approved the establishment of the AGU Committee on Mineral Physics in March 1983 and charged the Committee to "provide service to the AGU and to the mineral physics scientific community." President Van Allen approved the appointments of Orson Anderson as chairman, and members Peter Bell, Raymond Jeanloz, Robert Liebermann, Murli Manghnani, Tom Shankland, Tom Ahrens, and Joseph Smith. The latter two members served ex officio as officers in the Tectonophysics and VGP sections, respectively.

The first meeting of the newly established Committee was held at Baltimore, Md., May 31, 1983, and subsequent meetings occurred at San Francisco, Calif., on December 7, 1983, and in Cincinnati, Ohio, on May 15, 1984. One of the Committee's first activities, in addition to coordinating meeting schedules, was to compile a list of mineral physics workers in order to identify the range of interest in mineral properties. This list rapidly expanded to more than 300 scientists in 20 countries, and it soon became evident that, just as mineral physics extends beyond the traditional bounds of any one AGU section, so also does it extend well beyond the scope of the earth sciences. Workers in ceramics, solid state chemistry, material science, and theoretical physics are regular contributors of significant results with direct applications to geophysical problems, yet many of these results are not known to AGU members. An expanded role for the Mineral Physics Committee was thus proposed. In addition to the original task of coordinating related AGU meeting sessions and other activities, the Mineral Physics Committee now seeks to foster links among all the diverse elements that comprise the mineral physics community. Committee activities thus include the organization of symposia, the development of a mineral physics monograph series, the active solicitation of mineral physics articles for AGU periodicals, and the distribution of a newsletter to the International list of researchers in mineral physics.

Under the chairmanship of Orson L. Anderson, Professor of Geophysics at the University of California, Los Angeles, several panels have been organized to undertake the activities of the Mineral Physics Committee. The AGU Sessions Program Panel (William Bassett, Charles Prewitt, David Kohlstedt, Charles Sammis, and Steven Kirby) is responsible for coordinating mineral physics abstracts in an effort to minimize conflicts between presentations of interest to the mineral physics community. As a first step it is recommended that contributors designate "Mineral Physics Session" on abstracts submitted to AGU meetings. This notation will ensure the inclusion of the paper in an appropriate session.

The Panel on Conferences and Publications (Alexandra Navrotsky, Donald Weidner, Tom Shankland, and Harve Waff) has examined the possibility of a new AGU monograph series on aspects of mineral physics. It is anticipated that the first titles in this series will be announced shortly. The panel is also considering possible topics for Chapman conferences.

The Membership and Publicity Panel (Robert Hazen, Earl Graham, Sue Kieffer, and Leon Thompson) is charged with the task of developing and maintaining a mailing list and with communicating news of interest to the mineral physics community. A growing list, expanded to more than 500 scientists from 30 countries, has been prepared. Requests for sets of pre-gummed labels for appropriate mailings will be considered by the panel. News will be communicated both through periodic "Mineral Physics News" sections of *Eos*, and through mailings to the entire list of mineral physicists, sponsored by a grant from the AGU Council. In this way, AGU will provide the much-needed headquarters for the diverse international mineral physics community.

The Panel on Long-Range Future of Mineral Physics (Orson Anderson, Peter Bell, Murli Manghnani, and Joseph Smith) has reported on the prospect of augmented federal research funding in mineral physics. A National Research Council (NRC) panel on the Solid Earth identified "physics and chemistry of earth materials" as one of "five research areas in which significant dividends can be expected as a result of incremental federal investment in FY 1985." Members of the panel will continue to seek opportunities to act in concert with NRC and agency officials to bolster the long-term future of mineral physics.

Other participants in the Mineral Physics Committee include the Nominations Panel (Roger Burns, Daniel Weill, and Hartmut Spetzler), Foreign Secretary (Robert Liebermann), Committee Secretary (J. Michael Brown), and AGU Section Liaisons to Tectonophysics (Tom Ahrens), to VGP (Joseph Smith), and to Geomagnetism and Paleomagnetism (Subir Banerjee). In addition to the original members of the Committee on Mineral Physics, two new members, Roger Burns and Alexandra Navrotsky, have been added.

Orson Anderson, Chairman

News & Announcements

Call for Mineral Physics Papers

The editors of *Geophysical Research Letters* (GRL) are attempting to increase submission rates in the fields of solid earth geophysics, and in particular in mineral physics. GRL, which is noted for its record of rapid publication, welcomes short, original articles of new results presented in a way that will make their significance apparent to the general geophysics community. Manuscripts should be sent to James C. G. Walker, Editor, *Geophysical Research Letters*, 2455 Hayward, Ann Arbor, MI 48109.

Mineral Physics News: Call for Contributions

Mineral Physics News will appear biannually in *Eos*.

News, notes, reviews, or other material of general interest to AGU and the mineral physics community are welcome. Please send information to the editor of *Mineral Physics News*. The next edition of Mineral Physics News will be published in April 1985. The deadline for copy is February 28, 1985.

Meetings

Developments in High-Pressure and High-Temperature

The Mineral Physics Committee, Tectonophysics Section, and the VGP Section plan a special session for the Fall 1984 AGU meeting in memory of John C. Jamieson. The session will be devoted to recent advances in the areas in which John worked and will include an invited talk on his contributions to geophysics. Additional invited papers by Murli Manghnani, William Bassett, Robert McQueen, and Buzz Graham, reviewing high-pressure crystallography, shock-wave work, and general high-pressure techniques, will complement the contributed papers. A special issue of the *Journal of Geophysical Research-Solid Earth* is being planned consisting of papers from this session. For further information contact Phil Halleck, 442 Dieke Building, Pennsylvania State University, University Park, PA 16802 (telephone: 814-865-1878).

High-Resolution Electron Microscopy

As part of the celebration of the centennial of Arizona State University there will be a symposium on high-resolution transmission and analytical electron microscopy from January 7–11, 1985. The goals are to review and evaluate developments in theory, techniques, and application that have been made to the present; and to evaluate new research directions that will arise from the next generation of instruments and techniques that are now becoming available. For further information contact Centennial Symposium, Center for Solid State Science, Arizona State University, Tempe, AZ 85287.

Microscopic to Macroscopic

A short course will be held immediately prior to the Spring 1985 AGU meeting on relations among thermodynamics, lattice vibrations, coordination geometries, and bonding in minerals. Many aspects of mineral physics, including spectroscopy, crystal chemistry, thermochemistry, phase transitions, and bonding will be integrated in an effort to demonstrate the close correlations between atomic-scale and macroscopic properties of minerals. The Mineralogical Society of America short course is primarily pedagogic in nature, and it is planned to complement that emphasis with a series of research presentations at an all-day symposium of the same title at the 1985 Spring AGU meeting. For more information contact Susan W. Kieffer, U.S. Geological Survey, 2255 North Gemini Drive, Flagstaff, AZ 86001.

Quantum Theory and Experiment Applied to Solids

Planning is now underway on a 5-day symposium to review developments in the description of structure and bonding in perfect crystals. This conference, which is to be held May 1986 at the University of Maryland, College Park, is in some ways a sequel to the successful conference on Structure and Bonding in Crystals, which was held at Castle Hot Springs, Ariz., in 1980. Discussions will include experimental and theoretical aspects of small gas molecules relevant to understanding solids, defect solids and glasses, oxide surfaces, and solution and gel species important in natural waters. For information contact Jack Tossell, Department of Chemistry, University of Maryland, College Park, MD 20742.

Mineral Physics Symposia

There will be one or more mineral physics symposia at the next International Mineralogical Association (IMA) meeting, July 13–18, 1986. Anyone wishing to organize or participate in an IMA symposium should contact Larry Finger, Geophysical Laboratory, 2801 Upton St., N.W., Washington, DC 20008.

Books

Proterozoic Geology

L. G. Medaris, Jr., C. W. Byers, D. M. Mickelson, and W. C. Shanks (eds.), *Mem. 161*, Geological Society of America, 315 pp., 1983, $49.00.

Reviewed by P. K. Sims

This book and its companion, *Early Proterozoic Geology of the Great Lakes Region (Mem. 160* Geological Society of America, 1984), edited by L. G. Medaris, Jr., are the products of an International Proterozoic symposium held at the University of Wisconsin, Madison, May 18–21, 1981. This volume contains 25 papers that present the current thinking of experts on many aspects of Proterozoic evolution of the earth; it is divided into five broad categories: tectonics, magmatism and metamorphism, mineral resources, evolution of life and the atmosphere, and glaciation.

The Proterozoic is a distinctive interval in the geologic history of the earth, encompassing the transition from Archean conditions to those of the Phanerozoic. By Early Proterozoic time, extensive stable continental plates existed, and deformation, deposition, and intrusion styles were comparable to those of today. Also, the amount of free oxygen in the atmosphere and hydrosphere continuously increased during the Proterozoic and eventually reached levels supportive of metazoan evolution.

The Early Proterozoic is characterized by thick epicratonic sedimentary sequences and oceanic-arc volcano-plutonic complexes, which are variably deformed. What tectonic processes were operative during this interval of time is a matter of controversy. The case for Wilson-cycle signatures analogous to modern plate tectonic regimes is presented by Brian Windley, who points to the well-exposed and well-documented Wopmay orogen in northwest Canada as an excellent example. In contrast, A. Kroner and A. J. Baer argue for ensialic orogens. The uniformitarian view favors Wilson-cycle orogeny, but is it possible that Proterozoic mobile belts underlain by gneisses developed as a result of tectonic processes unique to the Proterozoic (and Archean)?

Oxidation of the atmosphere during the Proterozoic is recorded in the rocks by changes in the nature and type of sedimentation, mineral deposits, and life forms. The interrelation of Proterozoic life, air, water, and sediments through time is ably reviewed by P. E. Cloud. Proterozoic chemical sediments are depleted in ^{18}O with respect to Phanerozoic analogues, and E. C. Perry, Jr., and S. N. Ahmed propose that the sediments were precipitated from a Proterozoic ocean depleted in ^{18}O. Others have proposed that the depletion resulted from a hot Proterozoic ocean. As an example of the change in the types of mineral deposits with an evolving atmosphere, J. J. Langford discusses the differences between the Early Proterozoic gold-uranium paleoplacers and the younger Proterozoic, high-grade unconformity-type concentrations. Exhalative massive-sulfide deposits, which formed most abundantly in the Early Proterozoic, are described by G. H. Gale; and another important deposit type, sediment-hosted lead-zinc deposits, is reviewed by I. B. Lambert.

In a significant paper, S. R. Taylor and S. M. McLennan show that clastic sedimentary rocks record the fundamental change in magma chemistry from relatively sodic Archean rocks to more potassic Proterozoic rocks. They demonstrate that rare-earth-element patterns are remarkably uniform in post-Archean sedimentary rocks and conclude that this reflects reworking of older crust. Another distinctive aspect of Proterozoic magmatism was the generation of anorogenic anorthosite, rapakivi granite, and ignimbrites in the interval 1,800–1,000 Ma. J. L. Anderson summarizes a large body of data on these igneous rocks and argues for an origin by fusion of lower crustal material in continental rift environments. F. J. Sawkins also emphasizes the importance of rifting to the formation of major Proterozoic ore deposit types.

Glaciation was widespread at intervals during much of the Proterozoic, and both the evidence for glaciation (W. B. Harland) and the nature of the record (J. C. Crowell) are reviewed.

Two papers are based on paleomagnetic data. J. D. A. Piper reexamines the case for a Proterozoic supercontinent, and D. J. Dunlop and L. D. Schutts present several examples illustrating how paleomagnetists decipher magnetic overprints and use them to date and interpret tectonic events.

Readers who seek an overview of all major aspects of Proterozoic geology are likely to be disappointed. For example, papers are missing on orogenic granitoid and volcanic rocks, and their significance in unraveling Proterozoic tectonic environments. This is a minor shortcoming, however, compared to the great value of the book. The authors and editors have succeeded in conveying the distinctive flavor of the Proterozoic. The book is well produced and nearly free of printing errors. It should be on the book shelf of all those interested in the earth's early geologic history.

P. K. Sims is with the U.S. Geological Survey, Denver, Colo.

Conservation of Water and Related Land Resources

Peter E. Black, Praeger, New York, xx + 209 pp., 1982, $28.95.

Reviewed by Lynton K. Caldwell

The author was quite clear about the purpose of this book and clearly achieved his intent. In his preface, the author states, "The purpose of this book is to acquaint the reader with a broad understanding of the topics relevant to the management of the nation's water and related land resources." The book is a product of the author's 20 years of work as a teacher, consultant, researcher, and student of watershed management and hydrology and has served as a text for a course entitled Soil and Water Conservation, which the author has taught at the State University of New York, College of Environmental Science and Forestry at Syracuse, New York. But it was also written with the intent to be of use "to informal students of water and land related resources on the national level as well." The objectives of Black's course at Syracuse and its larger purpose define the scope of the book which, again in the author's words, have been "(1) to acquaint students with principles of soil and water conservation; (2) to stimulate an appreciation for an integrated, comprehensive approach to land management; (3) to illustrate the influence of institutional, economic, and cultural forces on the practice of soil and water conservation; and (4) to provide information, methods, and techniques by which soil and water conservation measures are applied to land, as well as the basis for predicting and evaluating results." The book is written in straightforward nontechnical language and provides the reader with a set of references, a table of cases, a list of abbreviations, and an adequate index. It impresses this reviewer as a very well edited piece of work.

The contribution of this book to the literature of soil and water conservation appears to be precisely what its author intended. It is a very suitable book for introducing the reader to the basics of the subject. In seven chapters the author moves from consideration of the historical background of water and land use planning through a discussion of water law, the organizations at various governmental levels that are concerned with water resource policies, through a consideration of aspects of policy planning and pollution control, to a discussion of project evaluation. A sixth chapter, one of the longer, deals with projects and programs and is useful for a quick overview of how water projects come into being, although emphasis is on the technical and procedural aspects of program development and only marginally on their political origins. Finally, in a short final chapter the author comments on the concept of "conservation," analyzing its varied uses since the term was adopted by Theodore Roosevelt. All but this last short chapter are followed by summaries, which are of assistance to readers with no previous background in the subject.

This is not a book to which professionals in the field would turn to find the most recent information on the state of the art of land and water conservation or program evaluation. Nevertheless, it is up-to-date as of the time of its publication. It is a book written essentially for beginners, whether students in college or members of the general public, who would like to have some understanding of what the business of water management and conservation is all about.

Lynton K. Caldwell is with Advanced Studies in Science, Technology, and Public Policy, Indiana University, Bloomington.

Satellite Microwave Remote Sensing

Edited by T. D. Allen, Halsted, New York, 526 pp., 1983.

Reviewed by George H. Born

This book is a collection of papers that presents results of the analysis by European scientists of data from the Seasat mission. Seasat, launched in 1978, was the first satellite dedicated to microwave remote sensing of the oceans. The spacecraft carried a suite of four microwave sensors, including a radar altimeter, a synthetic aperture radar, a windfield scatterometer, and a scanning multi-channel microwave radiometer. These microwave sensors were supported by a visible and infrared radiometer.

Seasat operated for just over 100 days before its power system failed. In spite of its brief lifetime, the satellite returned a significant amount of unique data on the world's oceans. As evidenced by this book, the data are still under intense investigation by scientists around the world.

A year prior to the launch of Seasat, a group of European scientists submitted a joint proposal to NASA and NOAA for oceanographic, geodetic, and glaciological studies based on the use of Seasat data. The proposal was accepted, and this group became known as the Seasat Users Group of Europe (SURGE).

Almost 4 years after Seasat's launch, a meeting was held at the Royal Society, London, to present the results of the European research together with invited contributions from Canada and the United States. The results of this meeting are effectively summarized in the thirty papers comprising this book. The text is chiefly devoted to the analysis of Seasat data with a wrap-up paper describing plans for the European Space Agency Remote Sensing Satellite, ERS-1.

The 30 papers, each a chapter of the book, include an overview of the Seasat mission, two general papers on data acquisition and processing, two papers dealing with the scatterometer, 13 papers presenting results from the synthetic aperture radar, 10 papers related to the altimeter, and two papers summarizing scanning microwave radiometer results.

Many of the papers deal with a comparison of Seasat measurements of winds and waves to those measured by surface ships and

Books (cont. on p. 748)

EOS

Transactions, American Geophysical Union

The Weekly Newspaper of Geophysics

For speediest treatment of contributions, send three copies of the double-spaced manuscript to one of the editors named below and one copy to AGU.

Editor-in-Chief: A. F. Spilhaus, Jr.; **Editors:** Marcel Ackerman, Mary P. Anderson, David A. Brooks, Bruce Doe, C. Stewart Gillmor (History), Clyde C. Goad, Louis J. Lanzerotti, Robert A. Phinney; **Managing Editor:** Barbara T. Richman; **News Writer:** David W. Robb; **Copy Editors** Ruth Sochard; **Production Staff:** Celia Kate Burkhalter, Dae Sung Kim, Patricia Lichiello, Lisa Lichtenstein, Kathryn Meyer, Steven Mansberg.

Officers of the Union

Charles L. Drake, President; Peter S. Eagleson, President-Elect; Peter M. Bell, General Secretary; Juan G. Roederer, Foreign Secretary; James A. Van Allen, Past President; A. F. Spilhaus, Jr., Executive Director; Waldo E. Smith, Executive Director Emeritus.

For advertising information, contact Robin E. Little, advertising coordinator, at 202-462-6903 or toll free at 800-424-2488. Advertising must be informative and consistent with the scientific and educational goals of AGU and is subject to approval by AGU. Advertisers and their agents assume liability for all content of their advertisements and for any claims arising therefrom against the publisher. Offers in advertisements are subject to all laws and are void where prohibited.

Views expressed in this publication do not necessarily reflect official positions of the American Geophysical Union unless expressly stated.

Subscription price to members is included in annual dues ($20 per year). Information on institutional subscriptions is available on request. Second-class postage paid at Washington, D. C., and at additional mailing offices. *Eos, Transactions, American Geophysical Union* (ISSN 0096-3941) is published weekly by

American Geophysical Union
2000 Florida Avenue, N.W.
Washington, DC 20009

Cover. The photograph shows the tidal bore in one of the channels through the mud flats at Turnagain Arm, Alaska. It was taken at 1400 LT on September 4, 1983, from a lookout near milepost 95 on the Seward Highway (some 52 km up the arm from Anchorage). Low tide at Anchorage was -0.2 m at 1120 LT and high tide was 8.8 m at 1730 LT. The elevation of the lookout was estimated to be about 100 m and its distance from the channel about 1 km. A 35 mm camera with a 120 mm focal length lens was used. The bow-shaped leading bore wave has an undular character (Froude number, F = 1–1.7 (cf. D. F. Lynch, Tidal bores, *Sci. Am.*, *247*(4), 134–143, 1982) over most of the channel width, except near the banks where it is consistently breaking (F = 4.5–9.0) and along the banks where it is jetting forward (F > 9.0). Neglecting some nearshore interference effects, there appear to be three distinct wave trains following the leading wave: The central train has the greatest wavelength, and there are step decreases to the trains on both sides. The far and near wave trains can be seen to have different wavelengths because of counting waves from the leading one, the counts for far-center-near are 6–5-7, 11–9-15, 15–13-19, ?-17-26, and ?-21-33. This shows, perhaps, that there is a central, steep-sided channel set into an otherwise gently sloping bottom topography. The step up from the bottom of this central channel to the slope would be less on the far side than on the near side. It is suggested that the wave trains were created by the leading wave in a similar way that a vessel creates and carries with it a stern wave train whose wavelength is a function of vessel speed and water depth. The lengths of the wave trains would be related to the group velocities of the waves. For a vessel in deep water the length of the wave train is (ideally) half the distance that the vessel has traveled (R. A. R. Tricker, *Bores, Breakers, Waves and Wakes: An Introduction to the Study of Waves on Water*, Elsevier, New York, 1965). Unfortunately, no measurements could be taken of the bottom topography, the currents, or the characteristics of the bore, and so it was not possible to apply the equations for a tidal bore developed by Tricker. Students of waves would no doubt find it challenging to concurrently take measurements of this tidal bore and to film it.

Acknowledgment: The opportunity to take photographs of the tidal bore occurred when the writer was a visitor at the Institution of Marine Science at the University of Alaska, Fairbanks. (Photo contributed by George Cresswell, CSIRO Division of Oceanography, Hobart, Tasmania, 7001, Australia.)

Books *(cont. from p. 747)*

buoys. In general, these papers demonstrate that the Seasat sensors met or exceeded their measurement objectives. These include measuring oceanographic parameters such as wind speed and direction, sea surface temperature, sea surface topography, and wave height, length, and direction, as well as liquid and vapor water in the atmosphere.

Results of the Seasat mission have been instrumental in the European Space Agency's plans to fly the ERS-1 satellite, whose mission is described in the volume's final chapter. Also, Seasat results weighed heavily in NASA's planning for the TOPEX project to fly a 2-cm precision altimeter to map ocean circulation late in the decade. The U.S. Navy plans to fly the GEOSAT spacecraft next spring carrying a Seasat-class altimeter to complete the job of high-resolution mapping of the marine geoid begun by Seasat. In 1989, the U.S. Navy plans to fly the Navy Remote Oceanographic Sensing System (N-ROSS) carrying a suite of sensors similar to those aboard Seasat. Plans are underway in Japan and Canada to orbit, by the end of this decade, various microwave instruments derived from those flown on Seasat.

The papers in this edition are well written, and several present new results. The volume represents a significant contribution to the science of microwave remote sensing and is an excellent complement to the two special issues of the *Journal of Geophysical Research* (vol. 87(C5), April 30, 1982, and vol. 88(C3), February 28, 1983) which have been devoted to results of the Seasat mission. Several of the papers present analysis material tutorial in nature and not readily available elsewhere. With the dramatic increase in oceanographic microwave remote sensing scheduled for later in this decade, this book takes on significant additional importance and represents a worthwhile addition to the library of anyone having an interest in remote sensing of the oceans.

George H. Born is with the Center for Space Research, The University of Texas at Austin, Austin, TX 78712

Classified

RATES PER LINE

Positions Available, Services, Supplies, Courses, and Announcements: first insertion $5.00, additional insertions $4.25.

Positions Wanted: first insertion $2.00, additional insertions $1.50

Student Opportunities: first insertion free, additional insertions $2.00.

There are no discounts or commissions on classified ads. Any type style that is not publisher's choice is charged at general advertising rates. *Eos* is published weekly on Tuesday. Ads must be received in writing by Monday, 1 week prior to the date of publication.

Replies to ads with box numbers should be addressed to Box ___, American Geophysical Union, 2000 Florida Avenue, N.W., Washington, DC 20009.

For more information, call **202-462-6903 or toll free 800-424-2488.**

POSITIONS AVAILABLE

Postdoctoral Scientist/Trace Element Biogeochemistry. The Academy of Natural Sciences' Benedict Estuarine Research Laboratory has an immediate opening for a postdoctoral scientist interested in trace metal interactions with biota and transport through estuarine ecosystems. Successful applicant will interact with a small group of geochemists and biologists studying arsenic transformation and transport. Ample opportunity for research in the applicant's area(s) of interest. BERL is a small research laboratory located on the Chesapeake Bay, approximately 40 miles from Washington, D.C. Initial appointment is for one year, with possible extension to two years. Please call for information or submit curriculum vitae, summary of research interests, and names, addresses and telephone numbers of three references to: James G. Sanders, Benedict Estuarine Research Laboratory, Benedict, MD 20612, 301-274-3134.

American Museum of Natural History. The Department of Mineral Sciences is seeking to fill a tenure track position for Assistant Curator beginning July 1985. This is mainly a research position, but some time is needed for collections management and departmental activities. High quality sample oriented research and publication is the prime responsibility. The field of specialization is mineralogy, broadly defined, and may include and combine aspects of petrologic mineralogy, ore mineralogy, mineral geochemistry, crystal and thermochemistry, mineral physics, X-ray crystallography, ultrastructure analysis, crystal growth, spectroscopy or gemology. Major research facilities include a fully automated ARLSEMO electron microprobe, X-ray laboratory, minicomputer, and vast mineral and other collections. The opportunity exists for research and/or teaching collaboration with nearby institutions such as Columbia (Lamont-Doherty Geological Observatory).

Requirements are a Ph.D. in hand by the time of appointment and an ability to carry out a research program. It is expected that some research support will be sought outside the Museum. Applications should include: (1) a curriculum vitae, (2) names of three persons familiar with your work, and (3) a statement of research interests and specific projects to be carried out within the next five years.

These must be submitted by November 15, 1984 to:

Martin Prinz
Chairman, Search Committee
Department of Mineral Sciences
American Museum of Natural History
New York, NY 10024

An equal opportunity (M/F/H) affirmative action employer.

Applied Geophysics/Bowling Green State University. The Department of Geology invites applications for a tenure track, assistant professor position in applied geophysics. Salary up to $30,000; Ph.D. required. The successful candidate will be expected to develop a research program in some aspect of applied geophysics and teach courses in geophysics, exploration geophysics, and in his or her specialty. The Department has 11 full-time faculty. In addition, two faculty from the Physics Department participate in our geophysics program. Computer physical instrumentation, including a seismograph station and rock mechanics lab, are available.

Interested persons should send resume, statement of research interests, official transcripts, and three letters of reference to Charles M. Onasch, Chairman, Search Committee, Department of Geology, Bowling Green State University, Bowling Green, Ohio 43403. The closing date is November 30, 1984. We will be interviewing at GSA in Reno. BGSU is an equal opportunity/affirmative action employer.

Executive Director. Executive Director of newly established Incorporated Research Institutions for Seismology (IRIS), a non-profit consortium of about 40 research universities. Initial duties include setting up Washington, D.C. office with associated financial and clerical services, conducting necessary contract negotiations with federal agencies and private organizations, handling procedures and arrangements for extensive committee activities, and working with the managers of the various research programs. Under supervision of the President, represents the corporation as necessary in dealing with member institutions, funding agencies and contractors in administering large scientific programs. The corporation anticipates a level of research exceeding $20 million annually in five years, with a permanent office staff of up to ten. Candidates must be able to work independently, with little staff support in the first year, and have sufficient breadth and experience to establish an efficient, functioning corporate office. Applicants should submit resumes and names of at least three references to: IRIS, Inc., Department ED, 2000 Florida Avenue, N.W., Washington, D.C. 20009.

IRIS is an equal opportunity employer.

Physical Oceanographer. The Physical Oceanography Branch of the U.S. Naval Oceanographic Office seeks full-time Oceanographers for the study of the effects of oceanic current and thermohaline structure on undersea systems using data collected from various platforms for a variety of projects. The projects involve the collection, analysis and reporting of physical oceanographic data directly applicable to Navy environmental requirements. Up to 50% field duty may be required.

Multiple vacancies at the GS-7, 9 and 11 levels are available depending upon qualifications and experience and will remain open until filled. Salary range: $17,221 to $33,139.

Please contact (for required forms): Debra Staples, #N00—72(84), Commercial 601-688-5720, Autovon 485-5720, or FTS 494-5720, U.S. Naval Oceanographic Office, Management & Personnel Division, Personnel Operations Branch, Code 4320, Bay St. Louis, NSTL, Mississippi 39522.

Structural Geology and Tectonics. The Department of Geosciences at the University of Arizona is pleased to announce a new position in the general area of structural geology and tectonics. We seek a creative scientist with an interest in the structure and evolution of the earth's crust, someone who can bring new approaches to crucial problems in the evolution of orogenic systems combined with more traditional and modern methods. Candidates should expect to teach undergraduate structural geology, develop new graduate course material to complement and extend existing programs, advise graduate research, and carry out an active research program in their area of special interest. The academic level and salary will be dependent upon the experience and qualifications of the successful candidate. The position will be available Fall, 1985.

APPLICATION DEADLINE: November 1, 1984. Applicants should send curriculum vitae, bibliography, statement of research interests, and the names of four professional references to: George H. Davis, Department Head, Department of Geosciences, The University of Arizona, Tucson, AZ 85721.

The University of Arizona is an equal opportunity/affirmative action employer.

Paleobiology and Quaternary Paleoecology Positions/University of Tennessee. The Department of Geological Sciences, UT Knoxville (main campus), invites applications for two tenure track teaching and research positions at the Assistant Professor level.

(1) *Paleobiologist*—Applicants should have research interests in paleobotany, micropaleontology, or invertebrate paleontology.

(2) *Quaternary Paleoecologist*—Applicants should have research interest in terrestrial floras and/or paleoclimatology. This is a 3/4-time appointment made jointly with the Graduate Program in Ecology.

Both positions will be effective September 1, 1985, and applications are due by January 5, 1985. Ph.D.'s are required. Send resume, transcripts, and names of three referees to: Search Committee, Department of Geological Sciences, University of Tennessee, Knoxville, TN 37996.

UTK is an EEO/Title IX/Section 504 employer.

College of Geosciences/University of Oklahoma. Applications and nominations are invited for the position of Director of the School of Geology and Geophysics. The Director is expected to have a Ph.D. or equivalent, a strong, ongoing research program and administrative experience; industrial experience helpful; field of geological specialization open; to begin July 1, 1985; salary to be negotiated. In 1986, the School will move into the new 300,000 sq. ft. Energy Center along with other elements of the College of Geosciences; the Oklahoma Geology Survey; and the School of Petroleum and Geological Engineering and the School of Chemical Engineering and Materials Sciences, both from the College of Engineering.

Applications with curriculum vitae, names and addresses of three references, and/or nominations should be sent to:

Francis G. Stehli, Dean
College of Geosciences
University of Oklahoma
601 Elm Street, Room 438C
Norman, OK 73019.

Consideration of applications will begin January 1, 1985.

The University of Oklahoma is an Equal Opportunity/Affirmative Action Employer.

Postdoctoral Position/Naval Postgraduate School. The Ocean Turbulence Laboratory has available a postdoctoral position for a person interested in the analysis and interpretation of oceanic turbulence data. The tenure is for one or two years. The successful candidate should have a Ph.D. in physical oceanography and although experience with turbulence data is preferable it is not essential. The opportunity for involvement in data gathering expeditions is also available. Resumes can be sent to Dr. R.G. Lueck, Code 68 Ly, Naval Postgraduate School, Monterey, CA 93943.

AA/EOE.

Department of Geosciences/University of Houston. The Department of Geosciences has permission to hire at least one geophysicist to complement the 16 members of our faculty (3 in Geophysics). This is a tenure track position with a starting date of August, 1985. We are particularly interested in talking with individuals with strong backgrounds in theoretical and experimental seismology. Salary and rank will be determined on an individual basis. Applicants should submit: (1) a curriculum vita; (2) a brief statement outlining research interests; (3) a brief statement outlining teaching interests; (4) three letters of recommendation; (5) a copy of graduate transcripts.

John C. Butler
Geosciences
University of Houston, University Park
Houston, Texas 77004.

Several of my colleagues and I will be at the GSA meetings in Reno and would like to talk with potential applicants.

The University of Houston is an equal opportunity/affirmative action employer.

Director: Atmospheric Sciences Research Center/State University of New York at Albany. The State University of New York at Albany invites nominations and applications for the position of Director of the Atmospheric Sciences Research Center. The main purposes of the university-wide center, located adjacent to the main campus of the State University of New York at Albany, are: a) to promote and encourage programs of research in basic and applied sciences, especially as these relate to our environment and b) to encourage the fullest possible participation in these research activities by faculty and students throughout the university and in all appropriate industrial, governmental, and educational groups.

Qualifications: Scientists of international reputation having a record of publications relating to atmospheric problems; involvement with research in own field and interest in research being conducted by colleagues; proven ability in administrative skills; desire and aptitude to communicate about science with students and the general public; success in securing funding for research from governmental, industrial, and other agencies.

Inquiries, nominations, or applications with supporting resumes should be directed to John Shumaker, Vice President for Research and Educational Development, State University of New York at Albany, Albany, NY 12222. Application deadline: November 15, 1984.

SUNYA is an Affirmative Action/Equal Opportunity employer.

Applications from minority persons, women, handicapped persons and Viet Nam era veterans are especially welcome.

Structural Geology/Duke University. The Department of Geology invites applications for a senior-level tenured faculty position in structural geology. We are seeking an individual with a proven research record and international recognition in his/her field. The Department has active research programs in geophysics, sedimentology, geochemistry, igneous petrology, carbonate petrology, marine geology and paleontology; graduate programs for both the MS and Ph.D. degrees are offered. Applicants should send a curriculum vitae and names and addresses of six references. The position is to be filled by September, 1985. Closing date for applications and nominations is December 31, 1984. Applications, nominations and inquiries should be directed to Chairman, Search Committee, Department of Geology, Duke University, PO Box 6729 College Station, Durham, NC 27708.

Duke University is an equal opportunity/affirmative action employer.

Civil Engineering. The University of Notre Dame is seeking applications for a tenure track Assistant or Associate Professor position in its Department of Civil Engineering. Applicants should have an earned Ph.D. in Civil Engineering or an appropriately allied discipline; the initiative, scholarship, and creativity to direct a funded research program encompassing M.S. and Ph.D. students; and a demonstrated ability for quality teaching at the graduate and undergraduate levels. The successful candidate will strengthen the Department in at least one of the following areas: water quality, hydrology, environmental chemistry, soil mechanics, geotechnical engineering, design or structural analysis. Appointment will begin with the Fall 1985 semester or other agreed upon date. Send resume and names of three references to: William G. Gray, Chairman, Department of Civil Engineering, University of Notre Dame, Notre Dame, IN 46556.

Affirmative Action/Equal Opportunity Employer.

University of Utah: Structural Geology/Tectonics/Tectonophysics. The Department of Geology and Geophysics at the University of Utah seeks applications for a tenure track position in structural geology, tectonics or tectonophysics. It is anticipated that this position will be filled at the assistant professor level, but applications by more senior persons will be considered. The position requires a Ph.D. with emphasis in structural geology, regional tectonics or tectonophysics. The new faculty member will have the opportunity to teach in the area of his or her specialty and may also be assigned introductory level courses. The successful candidate will be expected to establish a vigorous research program involving graduate students. The person who fills this position will join an active program in structural geology and tectonics that includes both field projects and integrated geology/geophysics and mechanics/fluid chemistry studies of structures in the western Cordillera. There is an excellent opportunity to collaborate with other faculty in structural geology, sedimentology, geophysics, geochemistry and petrology. A vita, copies of publications, names of three persons that may provide references, and a letter outlining the candidate's research and teaching interests should be sent to: Dr. William P. Nash, Chairman, Department of Geology and Geophysics, University of Utah, Salt Lake City, Utah 84112-1183. Deadline for receipt of applications is December 1984 with the appointment starting in September 1985.

The University of Utah is an equal opportunity/affirmative action employer.

BERNARD PRICE INSTITUTE OF GEOPHYSICAL RESEARCH

TECTONOPHYSICS
Structural Geologist

Many detailed observations have been made on faulting and dyke emplacement in the Witwatersrand Basin. Recent studies on subsidence of intracontinental sedimentary basins encourage us to collate data on Witwatersrand rock deformations and isopachs and examine them in a single basin-wide framework. Related studies dealing with the geophysical fields of the Wits Basin are now in progress and the project holds promise of fresh insights on the mechanics of basin evolution.

We seek a structural geologist or tectonophysics worker who will undertake research on structural and tectonic problems associated with basin development.

SEISMOLOGY
Research Fellow

The Institute maintains a varied programme in seismology, including explosion-based and tremor-based crustal structure studies, and analysis of earthquake source mechanisms. We seek an engineer or geophysicist or physicist or geologist, who will take part in seismic field programmes, process digital seismic data, and gain experience in seismic interpretation. Electronics experience not a requirement but will be a distinct advantage.

MARINE GEOPHYSICS
Research Fellow

The Institute's marine geophysics programme led by Dr. Hugh Bergh is concerned with mapping and interpreting deep sea magnetic anomalies and study of the magnetic properties of dredged ocean floor rocks. These projects are aimed at understanding the present nature of the Africa-Antarctica ridge system and its record of sea floor spreading.

We seek a geophysicist or physicist or geologist, who is keen to take a vigorous part both in research cruises in the Southern Ocean and in subsequent data handling and interpretation. Capability in computing desirable, sea-going experience not a requirement but will be a distinct advantage. Two posts offered.

These posts will cover at least two years work, either at the higher degree or post doctoral level. Salary will depend on qualifications and background; annual bonus of one month's salary as well as normal University fringe benefits are payable.

The policy of the University is not to discriminate on grounds of sex, race, colour or national origin.

Applicants should submit a detailed curriculum vitae including the names and addresses of two referees by 26 October 1984 to the Deputy Registrar (Academic Staffing),

UNIVERSITY OF THE WITWATERSRAND
1 Jan Smuts Avenue, Johannesburg 2001
South Africa

University of California, Santa Barbara. Tenure track position in geography-oceanography, available July 1, 1985. Salary and rank are dependent upon qualifications; however, preference will be given at the Assistant Professor level. The Geography Department seeks applicants with backgrounds in Physical Oceanography and/or Air/Sea Interaction with an interest in Remote Sensing. Applicants must have a Ph.D., substantial qualifications in marine research, and a strong commitment to teaching and research. Submit resume and names of three referees to: Chairman, Search Committee; Department of Geography; University of California; Santa Barbara, CA 93106. Closing date: December 10, 1984. Equal Opportunity/Affirmative Action Employer.

Yale University/Solid Earth Geophysics. The Department of Geology and Geophysics is soliciting applications for a junior faculty position in solid-earth geophysics to begin in the academic year 1985–1986. Areas of interest to the department include seismology, exploration geophysics, mechanical and physical properties of rocks and minerals, geomagnetism, tectonophysics, and geodesy. Curriculum vitae, publications and the names of three or more referees should be sent by December 1, 1984 to Karl K. Turekian, Chairman, Department of Geology and Geophysics, Yale University, Box 6666, New Haven, CT 06511.

Yale University is an equal opportunity/affirmative action employer and encourages applications from all qualified scientists.

High Altitude Observatory Scientific Visitor Program/NCAR. Scientific visitor appointments at the High Altitude Observatory are available for new and established Ph.D's for up to one year to carry out research in solar physics, solar-terrestrial physics, and related subjects. Applicants should provide a curriculum vitae, including education, work experience, publications, the names of three scientists familiar with their work, and a statement of their research plans. Applications must be received by 15 January 1985 and they should be sent to: The HAO Visitor Committee, High Altitude Observatory, National Center Atmospheric Research, P.O. Box 3000, Boulder, Colorado 80307–3000.

NCAR is an Equal Opportunity/Affirmative Action Employer.

Graduate Assistantships in Physics, Space Physics and Atmospheric Sciences. Assistantships are available for graduate students seeking M.S. and Ph.D. degrees in Space Physics, Atmospheric Sciences or Physics, at the University of Alaska. Research areas include both Experimental and Theoretical studies in Space Plasma Physics, Solar Physics, Computational Physics, Radio Physics, Atomic and Molecular Spectroscopy, Atmospheric Optics, Atmospheric Dynamics, Atmospheric Chemistry, Physical Meteorology and Climatology. Thesis research is conducted through the Geophysical Institute. The stipend is $12,000 to $15,000 per year depending on credentials. Students with B.S. degrees in Physics, Atmospheric Sciences, Electrical or Mechanical Engineering are encouraged to apply. For more information, write to Professor J.R. Kan, Head, Department of Space Physics and Atmospheric Sciences, or Professor G. Sivjee, Head, Department of Physics, University of Alaska, Fairbanks, Alaska 99701 or call 907-474-7513.

Environmental Chemist. The Illinois State Water Survey, Atmospheric Chemistry Section, at the University of Illinois, seeks applicants for research on airborne metallic and organic hazardous wastes (HW). M.S. with research experience, or Ph.D. Applicants should have strong preparation in organic chemistry, skills in atmospheric sampling, lab procedures, data analysis, and oral and written presentation of results. Successful candidate will review status of HW incineration in Illinois, review current methods for airborne HW sampling and analysis, develop or adapt sampling methods, and carry out atmospheric measurements of HW concentrations. Good opportunity for applicant seeking to develop a research program in airborne HW. Salary low 20's to low 30's, depending on qualifications. Closing date: October 31, 1984. Send resume to Dr. Donald Gatz, ISWS, PO Box 5050, Champaign, IL 61820.

The University of Illinois is an Affirmative Action/Equal Opportunity Employer.

Hydrogeologists/Illinois State Geological Survey. Positions are available for research staff to study problems involving hazardous and radioactive waste disposal and groundwater resource evaluation. Applicants should possess an advanced degree in hydrogeology or related field and have strong communication skills. Send a letter of application, resume, list of three references and list of publications to: Marilyn Rebecca, Personnel Office, Illinois State Geological Survey, 615 E. Peabody Drive, Champaign, IL 61820 by October 31, 1984.

The Illinois State Geological Survey is an equal opportunity/affirmative action employer.

Scientist. The National Space Science Data Center (NSSDC), at Goddard Space Flight Center is seeking an experienced scientist to work with the NSSDC ionospheric data archive, and to acquire additional data and documentation as appropriate. Applicants must have a Ph. D. and should have at least five years experience in the compilation and use of multiple ionospheric datasets. Applicants must have a broad overview of available ionospheric data sources, and must be experienced in the use of computer systems. Send resumes to:

Don Sawyer
Sigma Data Services Corp., a M/A-COM Co.
Code 633
NSSDC: Goddard Space Flight Center
Greenbelt, MD 20771.

Postdoctoral Fellow/Columbia University. The Aldridge Laboratory of Applied Geophysics of Columbia University solicits applications for a postdoctoral fellow position to participate in challenging research in wave propagation in the Magnetosphere. A Ph.D in geophysics, physics or applied mathematics is required.

Applicants should demonstrate a strong background in wave theory and numerical methods.

Send curriculum vitae, list of publications, research interests and names of three references by November 15, 1984 to:

Prof. Philip M. Carrion
828 B Mudd Building
Columbia University
520 West 120th Street
New York City, NY 10027.

Columbia University is an equal opportunity employer.

R&D Software Support for Oceanography, Hydrography, Navigation and Cartography/Science Systems & Applications, Inc. (SSAI). SSAI provides scientific data aquisition, data management, modeling, and analysis support to NASA/NOAA and the Navy in the metropolitan Washington, DC area. For NOAA's hydrography survey and marine charting needs, SSAI is anticipating openings for algorithm development, software design, development testing, documentation and maintenance areas. Applicants must have BS, MS and PhD degrees and extensive experience in structured programming on micro/mini and mainframe computers.

Please send your resume with salary history and references to:

Science Systems & Applications, Inc.
10210 Greenbelt Road, Ste 640
Seabrook, MD 20706.

EOE/M/F.

Post Doctoral Fellow in Geophysical Fluid Dynamics (G.F.D.)/University of Southern California. To organize and perform experiments, analyze data and present the results in oral and written form for the problem of flow over topography in rotating-stratified fluid systems. Ph.D. in suitable Engineering or scientific discipline required. Knowledge of micro-processor based data acquisition systems essential. Position available immediately for a two-year period. Salary commensurate with experience. A complete resume and at least three letters of recommendation should be sent to Prof. T. Maxworthy, OHE 430, Department of Mechanical Engineering, University of Southern California, Los Angeles, CA 90089–1453.

EOE/M/F/H.

Saint Louis University. The Department of Earth and Atmospheric Sciences invites applications for a tenure-track assistant professor position in geophysics effective for the fall of 1985. We seek an individual with broad interests who will complement active research programs in seismology and earth structure. Preference will be given to candidates who can teach existing courses in plate tectonics, geomagnetism and/or geoelectricity. The successful candidate must have a Ph.D. degree and will be expected to maintain an active research program, to teach geophysics courses at the undergraduate and graduate levels, and to supervise graduate student research. The application deadline is January 15, 1985. Applicants should send a curriculum vitae, a statement of research and teaching interest and the names of 4 professional references to:

Dr. Brian J. Mitchell, Chairman
Department of Earth and Atmospheric Sciences
Saint Louis University
PO Box 8099—Laclede Station
St. Louis, MO 63156.

Saint Louis University is an affirmative action/equal opportunity employer.

Soil Physics/Ag Engineering. Asst./Assoc. professor for full time, tenure track, teaching and research position at the University of Arizona. Research responsibilities relate to the use of experimental techniques, instrumentation, microcomputer interfacing, and data management and analysis in soil and water. Teaching responsibilities include micro-computer interfacing and measurement techniques in soil and water. Ph.D. in agricultural engineering, soil physics or related field with background in instrumentation, micro-computer interfacing and soil and water engineering or physics. Send resume, transcripts, list of publications and names of three to five references to: H.L. Bohn, Search Committee Chairman, Dept. of Soils, Water and Engineering, Univ. of Arizona, Tucson, AZ 85721. Position open until January 15, 1985 or until a suitable candidate is identified.

An Equal Opportunity/Affirmative Action employer.

Hydrogeologist or Hydrologist. The Kansas Geological Survey, a division of The University of Kansas, solicits applications for a hydrogeologist or hydrologist. Permanent, full-time position subject to annual review. Salary Range: $20,000—$30,00 per year, depending on qualifications. Required qualifications: Master's degree in hydrogeology or hydrology. Ability to develop, conduct, and participate in hydrogeologic and hydrologic studies, evaluating ground-water resources in Kansas, including field work as needed. Ph.D. in hydrogeology or hydrology and/or publication records or proven experience preferred.

Freedom to conduct research within the framework of the KGS Geohydrology Section's programs and support of a university environment. Opportunity for graduate study or teaching; and fully funded research opportunities in excellent research facilities.

Contact Personnel Manager, Kansas Geological Survey, 1930 Constant Avenue, Campus West, The University of Kansas, Lawrence, Kansas 66044 (Ph. 913-864-3965) for full position description, or to apply, send resume, college transcripts and list of published research. Applications received on or before December 28, 1984 will be considered.

An equal opportunity/affirmative action employer.

Manager, Research Computer Facility. The University of Oklahoma is looking for a person to manage a recently purchased VAX 11/785 computing facility dedicated to research in the Geosciences. Hardware and Software are designed for image processing, seismic reflection data processing, and graphical display of geological, geographical and geophysical data.

In addition to the 11/785 with 8mb of CPU memory, the system includes an array processor, five tape drives, five disk drives, a line printer, a 36" electrostatic plotter, and two high resolution graphics work stations with a digitizing board. The image processing hardware includes a Gould-DeAnza IP8500 processor with 16 image memory planes, real time disk memory and three high resolution color monitors.

The person selected must have at least a BS degree in science, math, engineering or related field; two years programming experience including FORTRAN; educational or computing experience in solid earth geophysics or meteorology. Experience with the VAX VMS operating system as well as supervisory experience are desired.

Salary is negotiable. People interested in the position should send a resume, copies of academic transcripts, and the names, addresses and telephone numbers of three references to:

John Wickham, Director
School of Geology & Geophysics
University of Oklahoma
Norman, OK 73019

Applications must be received by November 2, 1984.

Solid Earth Geophysicist. Faculty position at the Graduate Department of Scripps Institution of Oceanography and the Institute of Geophysics and Planetary Physics. Applications are invited for a tenure track faculty position in the field of solid Earth geophysics, including its theoretical and observational aspects. The position will involve graduate level teaching and the supervision of graduate student research. Qualifications include a Ph.D. in one of the sciences and demonstrated excellence and independence in research. Weight will be given to evidence of superior teaching ability. An appointment at the Assistant Professor level is envisaged but qualified applicants at all levels will be considered. Associate or professorial level candidates must demonstrate a strong research record in their specialty; assistant level candidates will be expected to show evidence of their potential by means of a publication record appropriate for their experience and in their letters of recommendation. Salary commensurate with qualifications and experience. Send letter of application, curriculum vitae, including research interests, and the names of three references to: Chairman, Graduate Department A-008, Scripps Institution of Oceanography, University of California, San Diego, La Jolla, CA 92093. Responses must be received by November 30, 1984.

An equal opportunity/affirmative action employer.

Faculty Positions in Meteorology. Applications are invited for two tenure track or tenured faculty positions in the Division of Meteorology and Physical Oceanography in the Rosenstiel School of Marine and Atmospheric Science of the University of Miami. The rank and salary will be negotiated depending upon qualifications. Applicants must hold a Ph.D. in atmospheric science or closely related fields. We are especially seeking applications from those interested in 1) *climate dynamics*, including observational studies of all aspects of the general circulation and its interannual variability, and 2) *mesoscale meteorology*, with emphasis on studies of regional dynamics of the marine environment, although qualified candidates in other areas are also encouraged to apply. The successful candidates will be free to pursue active research programs with a limited amount of graduate-level teaching. Applicants should submit curriculum vitae and the names of three references to: Dr. Eric J. Pitcher, Chairman of Search Committee, Rosenstiel School of Marine and Atmospheric Science, University of Miami, 4600 Rickenbacker Causeway, Miami, Fla. 33149.

The University of Miami is a private, independent, international university and is an equal opportunity/affirmative action employer.

Department of Geology/Indiana University. The Department of Geology at Indiana University is seeking persons skilled in the application of physics to the solution of geologic problems. Special consideration will be given to applicants with demonstrated expertise and potential for outstanding research in one of the following areas:

(a) Solid Earth Geophysics—exploration geophysics, rock mechanics or seismology.

(b) Mineral Physics—with special interests in the implications of changing mineral properties on geologic processes.

(c) Hydrodynamics—groundwater mechanics and the dynamics of sedimentary processes.

Indiana University has aggressive programs of research and teaching related to the above areas which it wishes to significantly expand. Successful applicants will be expected to assist in the expansion of these programs through interaction with current faculty as well as through development of new programs of interdisciplinary research.

We expect that appointments will be made at the assistant professor level; however senior scientists with superior records of success in publication and attraction of research funding also will be considered for a higher level. One appointment will be made for the 1984–85 academic year. We anticipate making two more appointments in successive years.

We will be interviewing at the Geological Society of America meeting in Reno, Nevada, November 5–8, 1984 and the American Geophysical Union Fall Meeting in San Francisco, California, December 3–7, 1984.

Inquiries and formal letters of application, including resume, should be sent to:

N. Gary Lane
Chairman
Department of Geology
Indiana University
Bloomington, IN 47405.

Indiana University is an affirmative action/equal opportunity employer.

University of Wyoming/Department of Geology and Geophysics. The Department of Geology and Geophysics encourages applications from students interested in pursuing graduate research in the fields of igneous and metamorphic petrology and geochemistry. Current research topics, involving field and laboratory studies, include: island arc and continental volcanics, petrogenesis of granitic and anorthositic rocks, evolution of the Archean crust, petrogenesis of mylonitic rocks, and geothermometry and geobarometry as applied to the evolution of orogenic terranes. Facilities include an analytical geochemical lab for whole-rock and trace element analysis, a fully automated CAMECA microprobe, two JOEL scanning electron microscopes, a thermal ionization mass spectrometer for analyzing Rb-Sr, Sm-Nd, and U-Th-Pb isotopes, a microthermometry lab, and an experimental petrology lab. Applicants should contact:

Petrology/Geochemistry Program
Department of Geology and Geophysics
PO Box 3006, University Station
University of Wyoming
Laramie, WY 82071

Research Associate/University of Maryland. The Space Physics Group of the Department of Physics and Astronomy has an opening for a Research Associate for an initial one-year period with high likelihood of extension. The position involves research on energetic particles of solar and interplanetary origin. Applicants should possess a Ph.D. in a relevant area of physics or astrophysics, relevant research experience is highly desirable. Inquiries and applications should be addressed to Prof. Glenn M. Mason, Department of Physics and Astronomy, University of Maryland, College Park, MD 20742. Applicants should send a vita including complete bibliography and a description of research experience, and should arrange for the sending of at least three letters of reference.

The University of Maryland is an equal opportunity/affirmative action employer.

POSITIONS WANTED

Geologist/Geochemist. 33, M.A., Ph.D. 1983. Specializing in low temperature geochemistry and geochronology with extensive experience in Rb-Sr mass spectrometry. Several publications. Seeks industry, academic research, or government position. Box 027, American Geophysical Union, 2000 Florida Avenue N.W., Washington, DC 20009.

EXPERIMENTAL PHYSICIST

The MIT Center for Space Research seeks individual with background in space plasma physics or related field to assist in design, development, evaluation and construction of instruments for a variety of space missions. Direct experience in the design and construction of balloon, rocket or satellite-borne instrumentation is required. Includes opportunity for part-time data analysis and interpretation depending on the interests of the applicant.

Please send resume including list of publications to: Dr. H.S. Bridge, c/o MIT Personnel Office, 77 Massachusetts Avenue, E19-238, Cambridge, MA 02139.

MIT is an equal opportunity/affirmative action employer.

MIT

OCEANOGRAPHER

GS-1360-12,

SALARY $30,549–$39,711

The Remote Sensing Branch of the Naval Ocean Research and Development Activity (NORDA) located at National Space Technology Laboratories, Bay St. Louis, MS. is seeking qualified applicants for a physical oceanographer with experience and interest in research studies of ocean dynamics via satellite altimetry. Duties will include providing oceanographic interpretation of the GEOSTAT mesoscale product; aid in obtaining subject procedures for the production of mesoscale analysis; assist in the GEOSTAT Ocean Application Program (GOAP) through the coordination of ongoing objective and subjective data system development and interfacing with programmers to provide oceanographic guidance for software implementation; develop methods for the production of Expanded Ocean Thermal Structure (EOTS) bogus files from altimeter derived topography; responsible for reporting results through published technical reports, journal papers and technical briefings. Applicants must have, as a minimum, a bachelor's degree in oceanography or related disciplines, and a minimum of three years of professional experience or graduate education, or a combination of both. **Qualified applicants should contact the Naval Ocean Research and Development Activity, NSTL, MS. 39529. ATTN: Code 140 or call (601) 688-4640 for application forms.**

An EEO Employer | US Citizenship required

Travel Funds to Fall Meeting Available to Foreign Graduate Students

Grants of up to $250 are available to foreign graduate students studying in the U.S. for travel to the AGU Fall Meeting, December 3–7 in San Francisco, California.

The funds, a grant from the Short-Term Enrichment Program (STEP) of the U.S. Information Agency, are available to full-time foreign graduate students who are not receiving ANY U.S. government funds. Students in refugee, immigrant or tourist visa status are not eligible.

For complete eligibility requirements and an application, write or call:

Member Programs Department
American Geophysical Union
2000 Florida Avenue, N.W.
Washington, DC 20009
202-462-6903

Deadline: October 31, 1984

Meetings

Announcements

Water Demand

August 11–16, 1985 Water Demand: Sharing a Limited Resource— The 21st Annual Conference and Symposium of the American Water Resources Association, Tucson, Ariz. (Yoram Gordon, Greenhorne & O'Mara, Inc., 9001 Edmonston Rd., Greenbelt, MD 20770; telephone: 301-982-2846.)

The deadline for abstracts, which should be submitted in triplicate and should not exceed 200 words, is November 15, 1984.

Papers should discuss, evaluate, or present new and emerging technologies for and approaches to the management of water resources in light of the scarcity and limited availability of usable water in sections of the United States and many other parts of the world. The papers may relate to general application or to case studies of specific geographic areas. Among the topics to be addressed in conference sessions are strategic planning contributions to water resources problems; the identification, development, and management of new sources of water; the optimization of water allocation; water rights impact on water use; the conjunctive use of ground- and surface water, i.e., agricultural, domestic, and industrial; and the economic aspects of water utilization.

Water and Space

August 18–24, 1985 International Workshop on Hydrological Applications of Space Technology, Cocoa Beach, Fla. WMO, IAHS. (A. Ivan Johnson, 7474 Upham Court, Arvada, CO 80003.)

The deadline for abstracts (400–600 words) is November 30, 1984.

The workshop program will emphasize offered and invited oral or poster papers related to the input of remote sensing and remote data transmission to hydrologic models and geographic information systems. Field trips to the National Aeronautics and Space Administration's J. F. Kennedy Space Center and other points of interest are planned. An exhibit and demonstration of pertinent equipment, systems, and programs will be available, as will a display of related books and periodicals.

Meeting Report

Incoherent Scatter Radar User Workshop

The incoherent scatter radar technique has developed over the years into one of the most powerful tools for investigating physical processes in the upper atmosphere. The National Science Foundation (NSF) now supports a chain of four incoherent scatter facilities at Sondrestromfjord (Greenland), Millstone Hill (Massachusetts), Arecibo (Puerto Rico), and Jicamarca (PERU). Six European nations support the EISCAT facility in northern Scandinavia, and France also has a radar at St. Santin. Recently, the organizations reponsible for each of the six radars agreed to participate in a centralized data base being established at the National Center for Atmospheric Research (NCAR) to make their data more readily accessible to the scientific community at large.

The distribution of radars enables a number of scientific problems to be addressed involving global-scale phenomena. To facilitate the planning and development of coordinated studies using the radars, a workshop was held at SRI International in Arlington, on February 22–24, 1984. The workshop, attended by 50 scientists, was sponsored by the NCAR data base and by the Incoherent Scatter Working Group (ISWG) of the International Scientific Radio Union (URSI). Thanks to the careful preparations by the involved scientists, the workshop was very productive. It is likely to become an annual event.

Because the NCAR incoherent scatter data base is expected to become a major vehicle for developing coordinated studies, the first morning session was spent reviewing a draft report, edited by Vincent Wickwar of SRI International, describing the establishment and operation of the data base. This report originated from an earlier workshop held at NCAR in 1982, and has been elaborated to incorporate the agreements and recommendations of the scientific community made since then concerning operation of the data base. Data from recent incoherent scatter observing periods are expected to become available this summer, with older data being processed and entered into the data base over the next few years. Researchers interested in using these data are encouraged to contact Art Richmond (address and phone below) to help ensure that data of greatest interest become available on a convenient schedule.

The operation of the incoherent scatter radars has now become sufficiently routine that researchers can carry out experiments without having intimate knowledge of the equipment. Indeed, all interested researchers are strongly encouraged to propose scientifically sound experiments that will make good use of the radars. For the workshop, a representative from each radar prepared material describing its capabilities and the procedure for scheduling radar time. This material is being edited into a user guide by Richard Behnke of the NSF.

Most of the workshop was devoted to planning coordinated experiments for the next year and a half. Twelve studies were developed on topics in thermospheric, ionospheric, and magnetospheric physics. They were summarized on the final day in a presentation by Michael Kelley of Cornell University and are described briefly below. Based on these proposed studies, plans for the 1984 and 1985 coordinated incoherent scatter observation schedules were developed in a session chaired by the URSI ISWG chairman, Murray Baron of EISCAT.

Thermospheric structure and dynamics was a topic of considerable interest at the workshop. The studies discussed concentrate on understanding and quantifying the complex global thermospheric response to variable energy inputs from the mesosphere below and from the sun and magnetosphere above. One major project, called the Global Thermospheric Mapping Study will look at this problem by collecting and analyzing simultaneous measurements from all six incoherent scatter radars, as well as from available satellites and from the international networks of Fabry-Perot interferometers, meteor-wind radars, MST radars, and partial-reflection-drift radars. Data will be available from all altitudes between 80 and 500 km, over a broad range of latitudes. Two observing periods of 3 days each around the solstices (June 26–28, 1984, and January 15–17, 1985) are currently planned. To incorporate the diverse data into a coherent global picture, and in order to interpret the variability in terms of the different energy sources, a combination of empirical and theoretical global models will be used to study effects related to global thermospheric and mesospheric circulation, atmospheric tides, thermospheric and ionospheric structure, and ionospheric wind dynamos. The study is being coordinated by W. L. Oliver and J. E. Salah of MIT Haystack Observatory.

Besides the Global Thermospheric Mapping Study, other projects were planned at the workshop for studying thermospheric dynamics under different conditions. For example, a campaign during the equinox of September 1984 is designed to examine the causes of reversals in north-south thermospheric circulation at mid-latitudes, as well as to detect wind dynamo effects associated with the circulation changes. A campaign is being planned to look for wind and temperature changes at Millstone Hill and Arecibo during the annular solar eclipse of May 30, 1984, and to compare thse with model predictions. Previous data acquired from the mid-latitude radars will be used to study solar cycle variations of thermospheric tides. Another proposed project intends to examine the sources and global propagation of gravity waves in the thermosphere.

Ionospheric electrodynamics was also a major topic at the workshop. Examination of global electric fields at relatively high time resolution is part of a project called Global Incoherent Scatter Measurements of Substorms (GISMOS). One 3-day campaign involving all six radars was carried out in January 1984, and another is planned for an equinox period in 1985. Several other types of measurements are also being used in the study. A variety of satellites are observing the particle and field environment of the earth; coherent-scatter radars are measuring motions of ionospheric irregularities; magnetometer and riometer chains are giving data on ionospheric currents and energetic particle precipitation; and a chain of Fabry-Perot interferometers from Greenland to Brazil is providing information on the neutral thermospheric behavior. The primary objective is to understand how ionosphereic electric fields behave at latitudes ranging from the polar cap to the magnetic equator during magnetospheric substorm events and how the fields are interrelated with other magnetospheric and thermospheric phenomena. In addition to the GISMOS campaigns, other coordinated electrodynamic observations are planned at the high-latitude incoherent-scatter stations to study high-latitude convection and magnetospheric cleft phenomena. A special experiment to try to measure large electric fields in the vicinity of the plasmapause and to relate these to electric field behavior at other latitudes was also proposed.

Other coordinated studies developed at the workshop concern the photochemistry of the 85–100 km height region at different latitudes and ionosphere-protonosphere coupling at low latitudes, using simultaneous observations at Arecibo and Jicamarca. Studies involving only a single radar were not a primary focus of this workshop; however, a large number of single-radar experiments will continue to be carried out in the future as in the past.

For further information on the meeting, including copies of the data base report, the user guide, the coordinated project outlines, and the URSI ISWG minutes, contact A. D. Richmond at NCAR, P.O. Box 3000, Boulder, CO 80307 (telephone: 303-497-1468).

This meeting report was contributed by A.D. Richmond, *NCAR, Boulder, Colo.*

AGU

1984 Top Sponsors

In the first 9 months of 1984, 1,784 new members were elected. The top sponsors, AGU members sponsoring three or more new members, are listed below.

Fifteen Members: A. Ivan Johnson.

Twelve Members: Robert B. Smith.

Eight Members: Stephen J. Burges, L. H. Meredith.

Seven Members: Soroosh Sorooshian.

Six Members: A. A. Bakr, Kazuya Fujita, John H. Trefry.

Five Members: William D. Gosnold, George Hornberger, H. J. Morel-Seytoux, Urho A. Uotila.

Four Members: Neville L. Carter, Richard G. Craig, Robert Geller, D. P. Hajela, Aaron A. Jennings, Richard H. Rapp, Pradeep Talwani, Sizuo Tsunogai.

Three Members: Mohd U. Ahmad, Thomas P. Armstrong, Daniel S. Barker, Kenneth E. Bencala, Shawn Biehler, Bruce A. Bolt, Stephen J. Burges, Randall J. Charbeneau, Thomas M. Church, Shirley J. Dreiss, Peter S. Eagleson, Richard W. Eppley, David L. Freyberg, Norman Gillmeister, Jeffrey A. Grosvenor, Gilbert N. Hanson, Stanley R. Hart, William J. Hinze, Robert T. Hodgson, George R. Jiracek, G. R. Keller, Attila Kilinc, Kenneth P. Kodama, David R. Lee, Maurice W. Major, Lawrence L. Malinconico, Miguel A. Marino, Thomas McEvilly, Fred J. Molz, Christopher N. K. Mooers, Stearns A. Morse, Gerald R. North, David F. Reid, Irwin Remson, Thomas C. Royer, Peter N. Shive, D. B. Stone, Ronald L. Street, Rob van der Voo, Ralph R. B. von Frese, Kenneth E. Windom, William S. Wise.

GAP

Separates

To Order: The order number can be found at the end of each abstract; use all digits when ordering. Only papers with order numbers are available from AGU. *Cost:* \$3.50 for the first article and \$1.00 for each additional article in the same order. Payment must accompany order. Deposit accounts available.

Send your order to:
American Geophysical Union
2000 Florida Avenue, N.W.
Washington, D.C. 20009

Exploration Geophysics

0920 Magnetic and electrical methods
SPECTRAL INDUCED-POLARIZATION PARAMETERS AS DETERMINED THROUGH TIME-DOMAIN MEASUREMENTS
Ian M. Johnson (Scintrex Limited, 222 Snidercroft Road, Concord, Ont., Canada L4K 1B5)
A method for the extraction of Cole-Cole spectral parameters from time-domain induced polarization data is demonstrated. The instrumentation required to effect the measurement and analysis is described. The Cole-Cole impedance model is shown to work equally well in the time domain as in the frequency domain. Field trials show the time-domain method to generate spectral parameters consistent with those generated by frequency-domain surveys. This is shown to be possible without significant alteration to field procedures. Cole-Cole time constants of up to 100 s are shown to be resolvable given a transmitted current of a 2 s pulse time. The process proves to have added usefulness as the Cole-Cole forward solution proves an excellent basis for quantifying noise in the measured decay.
GEOPHYSICS, VOL. 49, NO. 11

0930 Seismic methods
ARRAY ESTIMATORS AND THE USE OF MICROSEISMS FOR RECONNAISSANCE OF SEDIMENTARY BASINS
H.V. Asten (Formerly Macquarie University, N.S.W., Australia; presently Broken Hill Proprietary Co. Ltd., P.O. Box 559, Camberwell, Vic. 3124, Australia)
J.D. Henstridge
A "natural field" seismic technique is possible to attain by observing microseisms with a suitably designed array and by digitally processing the data to obtain estimates of the phase velocities of Rayleigh waves. Wavelengths of interest in detecting depth to the basement of sedimentary basins are in the range 2 to 20 km, and correspond to wave periods from 1 to 7 s. An array of five or seven seismometers deployed as an expanding cross configuration simplifies field procedures and is adequate for phase velocity measurements of Rayleigh waves in the required wavelength range, provided high-resolution frequency-wavenumber spectral analysis is used. This analysis can be implemented on a minicomputer in the field.
Results obtained from observation in a sedimentary basin of known structure show predominantly fundamental-mode Rayleigh wave propagation. The scatter of velocity estimates is small enough to allow inversion by curve matching, and depth to the basement can be computed to an accuracy of ±30 percent without requiring restrictive assumptions of a seismic velocity structure.
GEOPHYSICS, VOL. 49, NO. 11

0930 Seismic methods
SH-WAVE PROPAGATION IN HETEROGENEOUS MEDIA: VELOCITY-STRESS FINITE-DIFFERENCE METHOD
Jean Virieux (Formerly Department de Geotectonique, Laboratoire de Sismologie, Institut de Physique du Globe de Paris, Universite Paris VII, 4, place Jussieu-T 24, 4ème étage, 75005 Paris, France)
A new finite-difference (FD) method is presented for modeling SH-wave propagation in a generally heterogeneous medium. This method uses both velocity and stress in a discrete grid. Density and shear modulus are similarly discretized, avoiding any spatial smoothing. Therefore, boundaries will be correctly modeled under an implicit formulation. Standard problems (quarter-plane propagation, sedimentary basin propagation) are studied to compare the method with other methods. Finally a more complex example (a salt dome inside a two-layered medium) shows the effect of lateral propagation on seismograms recorded at the surface. A corner wave, always in-phase with the incident wave, and a head wave will appear, which will pose severe problems of interpretation with the usual vertical migration methods.
GEOPHYSICS, VOL. 49, NO. 11

0930 Seismic methods
A GEOPHONE SUBARRAY BEAM-STEERING PROCESS
Dale E. Howell (ARCO Exploration Company, P.O. Box 2819, Dallas, TX 75221) Larry F. Tooty and Alfred L. Liaw
The outputs of geophone array elements are conventionally summed into a single output trace. This summation attenuates incoherent noise, horizontally propagating surface waves, and obliquely incident events. The geophone subarray beam-steering process is a differential moveout and improves the resolution of incident angle of the seismic wavefront. [illegible] steering process transforms the data from the offset domain to the ray parameter (p) domain, and restricts the range of p as a function of time. Studies of synthetic and marine field data show that the beam-steering process improves the signal-to-noise ratio of obliquely incident events as compared to conventional subarray summing operations. The beam-steering process, compressing high-density data while preserving the high-frequency content of the seismic signal, is a cost-effective technique to process large quantities of closely spaced seismic data for stratigraphic exploration.
GEOPHYSICS, VOL. 49, NO. 11

0930 Seismic methods
A COMPARISON OF COMMON-MIDPOINT, SINGLE-SHOT, AND PLANE-WAVE DEPTH MIGRATION
P. Temme (Institut fur Meteorologie und Geophysik, der Johann Wolfgang Goethe-Universitat, Feldbergstrasse 47, D-6-0000 Frankfurt a.M. 1, Germany)
A comparison of common-midpoint (CMP), single-shot, and plane-wave migration was made for simple two-dimensional structures such as a syncline and a horizontal reflector with a laterally variable reflection coefficient by using synthetic seismograms. The seismograms were calculated employing the finite-difference technique. CMP sections were simulated by 18-fold stacking and plane-wave sections by slant stacking. By applying a finite-difference scheme, the synthetic wave field was continued downward. The usual imaging condition of CMP migration was extended in order to carry out migration of single-shot and plane-wave sections. The reflection coefficient was reconstructed by comparing the migrated wave field with the incident wave field at the reflector.
The results are:
(1) all three migration techniques succeeded in reconstructing the reflector position;
(2) as a consequence of the finite aperture of the geophone spread, only segments of the reflector could be reconstructed by single-shot and plane-wave migration;
(3) for single-shot and plane-wave migration the reflection coefficient can be obtained; and
(4) CMP migration may lead to incorrect conclusions regarding the reflection coefficient.
GEOPHYSICS, VOL. 49, NO. 11

0930 Seismic methods
THE RATIO V_P/V_S AS A DISCRIMINANT OF COMPOSITION FOR SILICEOUS LIMESTONES
Ray Wilkens (Department of Earth, Atmospheric, and Planetary Sciences, Massachusetts Institute of Technology, The Green Building, 54-314A, Cambridge, MA 02139) Gene Simmons and Lou Caruso
The ratio of the velocity of compressional waves, V_P, to the velocity of shear waves, V_S, is an important parameter for interpreting geophysical field data. Recent studies have emphasized the role played by pore geometry in controlling V_P/V_S in homogeneous rocks. We measured the carbonate content of a set of siliceous limestones of varying proportions of carbonate and silica and observed the pore structures of these samples using a scanning electron microscope. The range of V_P/V_S of individual samples during increasing confining pressure is [illegible] of V_P/V_S within the sample set as a whole is dominated by its carbonate content. Variations in V_P/V_S due to total porosity and pore geometry are around 0.1, whereas the change due to composition [illegible] (0.4). Values of pore aspect ratios gained from comparison of the velocity-porosity-composition data with theory are in good agreement with the electron microscope observations.
GEOPHYSICS, VOL. 49, NO. 11

Journal of Geophysical Research

Volume 89 Number B11 October 10, 1984

Geophysical Research Letters

Volume 11 Number 10 October 1984

Nominations for AGU Medals and Awards

William Bowie Medal. Awarded for outstanding contributions to fundamental geophysics and for unselfish cooperation in research.

Waldo E. Smith Award. Given for extraordinary service to geophysics.

John Adam Fleming Medal. Awarded for original research and technical leadership in geomagnetism, atmospheric electricity, aeronomy, and related sciences.

Walter H. Bucher Medal. Given for original contributions to the basic knowledge of the earth's crust.

Maurice Ewing Medal. Honors an individual who has led the way in understanding physical, geophysical, and geological processes of the ocean; who is a leader in scientific ocean engineering, technology, and instrumentation; or who has given outstanding service to marine sciences.

James B. Macelwane Award. Up to three awards are given each year for significant contributions to the geophysical sciences by a young scientist of outstanding ability. Recipients must be less than 36 years old on November 1 of the year preceding presentation of the award.

Send letters of nomination outlining significant contributions and curricula vitae directly to the appropriate committee chairman.

For the Bowie Medal:
Donald L. Turcotte
Department of Geological Sciences
Cornell University
Ithaca, New York 14850

For the Bucher Medal:
Rob Van der Voo
Department of Geological Sciences
University of Michigan
Ann Arbor, Michigan 48109

For the Smith Award:
J. Freeman Gilbert
IGPP A-025
University of California, San Diego
La Jolla, California 92093

For the Ewing Medal:
John M. Edmond
E34-266
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

For the Fleming Medal:
Thomas M. Donahue
Department of Atmospheric and Oceanic Sciences
University of Michigan
Ann Arbor, Michigan 48104

For the Macelwane Award:
Adam M. Dziewonski
Department of Geology
Harvard University
Cambridge, Massachusetts 02138

Deadline for Nominations is November 1, 1984